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THE NEW WATER-WORKS AND REINFORCED CONCRETE CONDUIT OF THE CITY OF MEXICO.

By James D. Schuyler,* M. Am. Soc. C. E.

The City of Mexico has under construction a new system of water-works which has many novel and interesting features, and which when completed will provide that thriving and beautiful capital with a supply of clear, cold, pure spring water, unsurpassed in quality by that of any city in the world, and under ample pressure to give adequate fire protection to the tallest buildings.

The work is being carried out by the Federal Government with an appropriation of $9,000,000 (Mex.) through a commission called the "Junta Directiva de las Obras de Provision de Aguas Potables," of which Senor Jose y Limantour is President, Senor Leandro Fernandez is Vice-President and Senores Gabriel Mancera, Andres Aldasoro, Pablo Macedo and Guilliermo Beltran y Puga are Directors. The plans have been made and are being executed under the direction of Senor Manuel Marroquin y Rivera, as Chief Engineer, or "Technical Director," as he is entitled.

The supply is being brought to the city in a conduit of reinforced concrete, a distance of 27 kilometers (about 17 miles), from large springs near the village of Xochimilco. The water comes out at several points in a distance of 2 or 3 kilometers, from the foot of the high mountains lying to the southeast of the city, and is practically constant and invariable in volume, the elevation of the springs being practically at the same level as the city, or but slightly higher. The porous basaltic formation of these mountains absorbs all the precipitation falling on them without material surface run-off, and throughout a very large area of barren lava there is almost an entire absence of streams or springs. This water, so absorbed, descends by filtration through the rock to the level of the valley, and there appears in the form of crystalline springs, issuing at a temperature of 13° C. (57° F.), in greater volume than will be needed for a much larger population than the city now contains.

In the original studies, it was proposed to carry the water by gravity from the springs to the city, giving the necessary grade by excavating a trench for it of constantly increasing depth to the main pumping station to be located near Chapultepec. As this would have placed the conduit very deep toward the lower end, and for more than half its length entirely below the water plane, it would have been more costly in excavation and incurred the danger of surface water filtration into the conduit. Besides these objections, the danger of encountering quicksands would have been greatly increased. It was therefore decided to locate it at such a depth, only, as would give a minimum cover of one meter (3.28 ft.) over the top, and pump the water into the upper end of the conduit by a low lift of 26 ft. at the springs. This requires it to skirt the foot of the hills around the margin of the valley where the elevation of the ground is of sufficient height to give the necessary depth of excavation and the required fall.

The grade of the conduit is 3 ft. in 10,000; its area 2.895 sq. meters, and its computed capacity is 1.775 liters per second, or about 40,500,000 gallons per 24 hours. By increasing the head of the upper end sufficiently to raise the hydraulic grade to .00042 and assuming n = .017 in Kutter's formula, which is the coefficient used by Mr. Marroquin y Rivera, the discharge will be increased to 2.212 liters per second or about 50,000,000 gals. per 24 hours. This seems quite a conservative estimate of probable discharge, as the interior of the conduit is very smooth, and answers to Kutter's rating of n = .011. This will provide 77 gallons per capita daily for a population of 650,000 people, in addition to the present supply from Chapultepec Springs. As the population is now somewhere about 400,000, the provision for future growth is an ample one.

At the lower end a pumping station is to be erected to elevate the water 53 meters (about 175 ft.) to a reservoir, to be constructed on the mesa near the historic battlefield of Molino del Rey, back of Chapultepec. This reservoir will be lined with masonry, and covered with reinforced concrete, in the form of groined arches to support a cover of earth to maintain the cool temperature of the water. The gate house of this reservoir will be a work of art, very ornate and handsome in appearance.

The pumps will be three-stage centrifugals, direct-connected to electric motors. A contract has been entered into with the Mexican Light & Power Co., Ltd., to provide the pumps and motors and do the pumping to the reservoir for a period of years for a price equivalent to about 1 ct. per 1,000 gallons. The same company will also pump the water from the springs into the conduit.

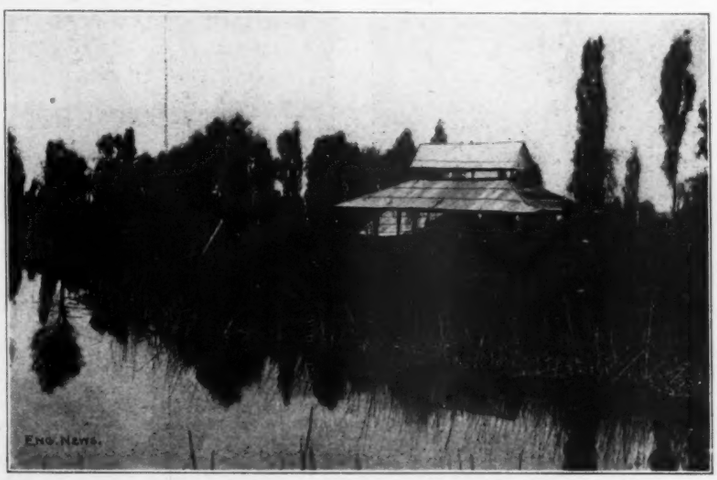
The equipment for building the conduit is remarkably complete, well-designed and up-to-date. A narrow gage railroad was first built on the right-of-way the entire length of the conduit, with necessary sidings and branches to a stone crushing plant about midway. The right-of-way provided is 25 meters (82 ft.) wide, which gives ample room for the railway, the trench and the spoil banks. An electric power transmission line was built alongside the trench, furnishing current to motors operating pumps, rock crushers, concrete mixers, etc. All the forms, and the sections of expanded metal reinforcement, are handled by means of a traveling derrick of St. Paul manufacture. The concrete mixers are supported on a track alongside the work, and easily moved ahead as the work progresses. They are of a well-known American type.

The rock used in the work is a hard basalt which crushes readily, and all the sand required is made in the crushing of the rock. The proportions used are 1:3:3. The concrete is mixed very wet, and requires but little tamping. The stone will all pass through a 2-in. ring. The stone costs $2.15 and the sand $1.75 per cu. m. The cement costs $6.40 per bbl. The average cost is about $55 per meter of conduit, or say $90,000 per mile. The excavation was let by contract for 23 cts. per cu. m., including pumping. Backfill, 13 cts. per cu. m. The wages paid to laborers are 75 cts. per day. (All price in Mexican silver.)

In January, 1906, the work had been completed for a distance of about five kilometers, and it was expected that the entire construction would be finished during the current year.

The accompanying section and six photographs show the details of the work very clearly, and must appeal to practical engineers as most admirably designed to facilitate rapid and economical construction. The writer has never seen anything better in the United States or in Europe.

[See pp. 436-7-8 for other illustrations.]



A PART OF THE SOURCE OF THE WATER SUPPLY OF THE CITY OF MEXICO.

(This is the principal one of the group of springs forming the water supply. The water is about 30 ft. deep and as clear as crystal.)

*Consulting Engineer, Los Angeles, Cal.

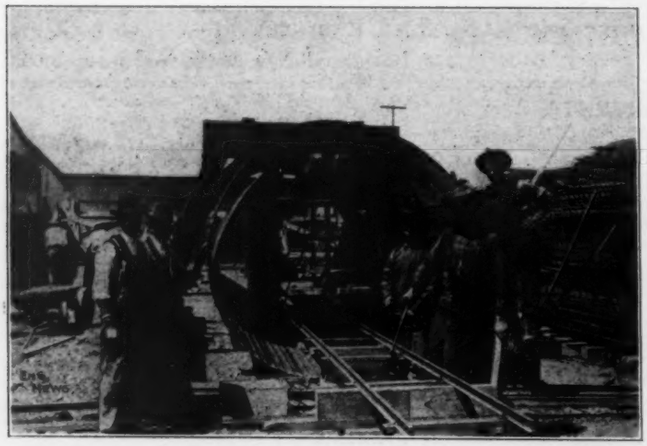


FIG. 1. A LENGTH OF EXPANDED METAL, WITH COLLAPSIBLE HINGED SHEET STEEL INNER FORM AND FRAME FOR OUTER FORM.

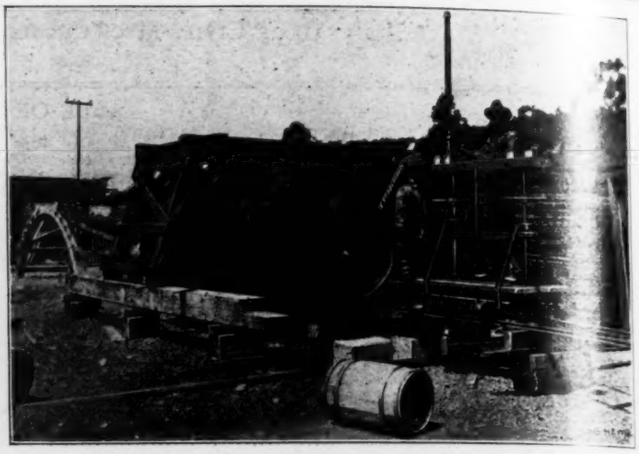


FIG. 2. SHOWING USE OF LONGITUDINAL TIMBERS TO SUPPORT EXTERIOR FORM-FRAMES.

(The expanded metal is rolled to shape and the forms are made at the warehouse yards at La Condesa, near Chapultepec. The longitudinal timbers, in actual construction, are alined and leveled after the bottom concrete, shown in Fig. 4, is in place.)

FIG. 3. TRENCH READY FOR LONGITUDINAL TIMBERS AND CENTRAL UNDERDRAIN.

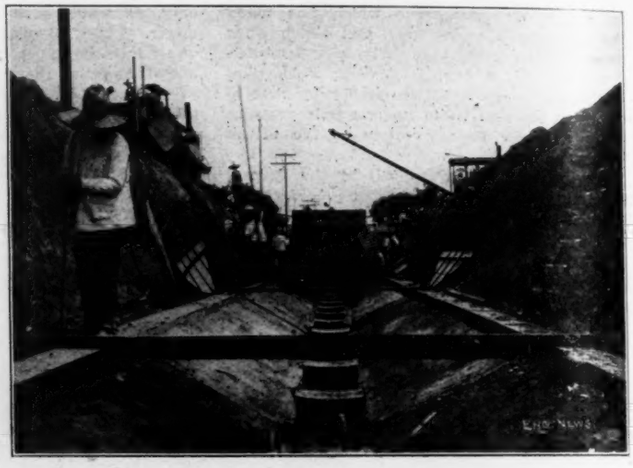


FIG. 4. TRENCH FULLY EXCAVATED, TIMBERS PLACED AND CONCRETE BLOCKS BUILT.

(The concrete blocks support the reinforcement. They are finally incorporated in the base of the conduit.)

REINFORCED CONCRETE CONDUIT CONSTRUCTION, CITY OF MEXICO.

AGITATION FOR ADOPTION OF THE METRIC SYSTEM IN THE UNITED STATES AND IN ENGLAND.

As some of our readers may be aware, a bill is pending in Congress to compel the use of the metric system in Government work; and quite a brisk campaign has been carried on by the friends of the metric system and those opposed to it. An excellent summary of this and also of the work for and against the metric system in England was given by the "American Machinist" in its issue of April 12, and we reprint it in part as follows:

A short time ago we mentioned a report made by the British Standards Committee in which mention we, through a misunderstanding, omitted to state that the committee named was appealed to by friends of the metric system in Great Britain to include in their recommendations of standard sizes, things to be made to metric dimensions. This, after careful consideration, the committee declined to do and all its recommended sizes are stated in English dimensions, though of course its recommended standards pertaining to electrical work are perforce based upon metric units. Though the committee's action with regard to metric dimensions of "shapes" and other things used in engineering construction is negative in character, it is nevertheless significant as indicating something of the obstacles to be overcome in Great Britain before the metric system can be generally introduced there.

In the meantime we have a communication from the Decimal Association saying that the prospects of favorable legislation by the newly elected Liberal Parliament are good, and another from the British Weights and Measures Association saying that there is no more chance of the metric system being adopted there than there is for ye editor becoming King of England. And as the editor is not even a candidate for the job, it will be seen that the chances are quite remote.

While among technical societies and organizations of manufacturers relatively little has been going on with regard to the matter, in other fields there has been much activity during the winter.

THE PENDING BILL.

About the beginning of the present session of Congress, Representative L. N. Littauer, of New York, who is a glove manufacturer, introduced a bill, the language of which is somewhat simplified as compared with former bills.

The bill reads as follows:

Be it enacted, etc., That from and after July 1, 1908, all of the departments of the Government of the United States in the transaction of business requiring the use of weights and measures shall employ and use the weights and measures of the metric system.

No exceptions are made and there is nothing in it about "the standard." Those who favor the bill declare that it will not and is not intended to have any effect upon manufacturers generally except as a concrete example of the workings of the system in actual use, while it will much simplify the work of the various bureaus of the government which, owing to their relations with foreign governments and with the work and literature of scientists, are now compelled to use it in part.

Those who oppose the bill declare that it is designed to be the entering wedge for the eventual displacement of our present weights and measures and for compelling our manufacturers to discard all their present expensive machinery and tools and reequip with metric-built machinery and tools. Members of the National Association of Manufacturers have been active in opposition to the bill on the ground stated above, regarding which objection Mr. Littauer says that it is a bugaboo fashioned by a few men and that he doubts its representing the intelligent opinion of the association.

THE "HERALD'S" CAMPAIGN.

By far the most active propaganda work that has been done so far has been carried on all winter by the "New York Herald" in favor of the system. We are not informed just how or why that paper has engaged in the fight, but probably it would not be far wrong to say that the American Board of Trade, of Paris, which strongly favors the adoption of the metric system here, has influenced the proprietor of the "Herald," Mr. Bennett, to take it up, Mr. B. having lived in Paris for some years, where a daily edition of his paper is also published.

The "Herald's" fight for the system is vigorously pushed, but in typical newspaper fashion—i. e., it confines itself strictly to the publication of such interviews, facts, opinions, etc., as are favorable to the metric system and rigidly excludes everything else.

Here in America the most noteworthy interview secured by the "Herald," from the engineer's point of view, is one from Charles H. Haswell, the venerable author of "Haswell's Engineer's Pocket Book," who is now about 93 years old and was a year ago elected an honorary member of the American Society of Mechanical Engineers. Mr. Haswell is consulting engineer to the Board of Estimate of New York City, and expressed himself as ready at any time to do his work to the metric system, he having had experience with it in his younger days and being familiar with it. He cited the interesting fact that, while chief engineer of the U. S. Navy he, in 1849, constructed the engines of the steam frigate "San Jacinto" to the metric scale. The arguments presented by the venerable engineer in favor of the metric system we do not repeat, for, though interesting because coming from a practical engineer nearly 97 years old, they are not new, but have been presented by many advocates.

Perhaps largely as a result of the "Herald's" campaign, the Board of Aldermen of the city of New York ordered, Jan. 16 by unanimous vote, the purchase of a set

FIG. 5. COMPLETED SECTION AND WORK IN PROGRESS.

of metric standards for the city, and both branches of the Legislature of the state of New Jersey passed resolutions Feb. 14 endorsing the Littauer bill and urging its passage by Congress. As a result of this agitation there are those who profess their belief that the pending bill will pass, while there are others who seem very confident that it cannot pass.

IN CANADA.

In Canada, too, some effort is being made looking toward the adoption of the system, and regarding this Consul Seyfert, of Stratford, writes:

With a view of adopting the metric system in weights and measures at an early day the Canadian Government is preparing and educating the people for change. Prof. J. C. McLennan, of the University of Toronto, has been engaged by the Dominion Government to devote the next year to explaining the system in a series of lectures in all the leading cities from Halifax to Vancouver. The professor delivered his first lecture on the subject at Stratford, Feb. 7, before the board of trade. According to his explanation it is the object of the Canadian Government to secure a uniform standard of weights and measures throughout the entire British Empire, and thus to advance trade relations among the different colonies of the empire. The board of trade at Stratford unanimously adopted resolutions, urging adoption of the system.

ENDOWMENT OF AN ANTI-METRIC BOOK.

Some time last fall a movement was started among machinery manufacturers to present to Messrs. Halsey and Dale a token of appreciation of their efforts in defense of the English system. At their suggestion, however, the money subscribed for the purpose was used as a campaign fund for the anti-metric cause. The copyright, plates and stock of printed copies of "The Metric Fallacy" were purchased from the publisher and the book was endowed, and a copy sent to each member of Congress with a slip attached to the title page bearing the following inscription:

To Senators and Representatives in Congress: This book has been endowed with funds collected by voluntary subscription among American manufacturers in order that a copy of it may be presented to all members of the Senate and House of Representatives.

This is not only an endorsement of the work of Messrs Halsey and Dale in making the first known collection of facts regarding the actual use of the metric system, but an earnest of the unwavering opposition of the manufacturers of this country to legislation for the adoption of that system.

An examination of its pages will show how widely the facts in the case differ from the assumption on which the metric case is based.

COMPLIMENTARY DINNER TO MESSRS. HALSEY AND DALE.

The committee in charge of the raising of the fund, consisting of J. H. Schwacke, of William Sellers & Co., chairman; H. N. Covell, of the Lidgerwood Manufacturing Company; Thos E. Durban, of the Erie City Iron Works; Wm. Lodge of the Lodge & Shipley Machine Tool Company, and Henry Sharpe, of the Brown & Sharpe Manufacturing Company, feeling that some further acknowledgment was appropriate, gave a complimentary dinner to Messrs. Halsey and Dale at the Waldorf-Astoria, New York City, the evening of March 31, Mr. Schwacke presiding and the other members of the committee being present except Messrs Durban and Sharpe. Others present as guests of the committee, besides those representing various technical journals, were: Geo. M. Bond; L. D. Burlingame, of the Brown & Sharpe Manufacturing Company; Marshall Cushing, Secretary National Association of Manufacturers; Geo. Moores, Secretary British Weights and Measures Association; Francis H. Stillman, of the Watson-Stillman Company, and W. A. Viall, of the Brown & Sharpe Manufacturing Company.

Following the dinner Messrs. Halsey and Dale were each presented with a cathedral-chime hall clock bearing the inscription, "The Man and The Hour."

THE SITUATION IN ENGLAND.

Among the after-dinner speakers was Mr. Moores, who outlined the situation in England, giving especially, particulars of the growing strength of his association. He also stated that the new British Prime Minister was recently asked if the Government would introduce a bill for the adoption of the metric system, to which he replied "No." He was then asked if he would permit such a bill to be introduced and discussed without the opposition of the government, to which he again replied "No." Inasmuch as, under parliamentary procedure, no bill can be passed to which the government is opposed, Mr. Moores considers that this action disposes of any possibility of the passage of a metric bill during the lifetime of the present Parliament.

Mr. Moores also announced that the firm of Willans & Robinson, of Rugby, England, who have been so often referred to as an example of the successful use of the metric system, had given him a written statement that hereafter their new work will be based upon the inch and not, as for several years past, upon the millimeter. In this connection it is proper to explain that Capt. Sankey, who always maintained that the system was successful there, is no longer with the firm.

Mr. Moores referred also to the action of the Engineering Standards Committee mentioned at the beginning of this article and said that, considering the manner in which this committee is made up to represent all branches of engineering and many branches of industry, he regarded its action as most significant.

We may remark that there is, however, considerable difference between the attitude of the British Weights and Measures Association and our own opponents of the metric system. Not a few members of the association named are using the metric system, prefer it to the present English heterogeneity and steadfastly refuse to join in the sweeping denunciations of the meter and of metric advocates. Some of these favor the decimalization of the present standards, and for acknowledging the shortcomings of the present system have been sharply rebuked by our own doughty champions of the inch, foot, pound and ton, who insist that the present system is all that could be desired and cannot be improved upon.

On the 4th of April Senator Beveridge introduced into the Senate a bill of the same import as that under consideration by the House committee, saying that he strongly favored such a start being made by the government, but was "not in favor of any attempt to force the metric system upon the business of the country in a way that would prove revolutionary."

On April 4 and 5 hearings were held by the House Committee on Coinage, Weights and Measures, which hearings took the form of a general round-up in which appeared a number of men representing both sides, and in the two days four hours were allowed each side.

Henry R. Towne, of New York, who appeared in opposition to the bill on the assumption that it would entail a great deal of expense for manufacturers, proposed that the committee recommend a bill providing that the President should appoint a commission composed of representative business men, scientists, educators and engineers, who should examine and report upon the whole question.

This, it is understood, completes the hearings, though ten days' time (until the 17th of April) is given for the filing of statements by any who wish to do so and have not appeared before the committee.

Though there has been and is in connection with this discussion a good deal of personal bitterness and misunderstanding, as there always will be when opinions run counter to pecuniary interests, or are made to appear to do so, the question seems likely to be finally decided upon its merits, for there is no politics in it, and so far as we have heard, no advocate of the pending bill has been charged with being influenced by any ulterior motive.

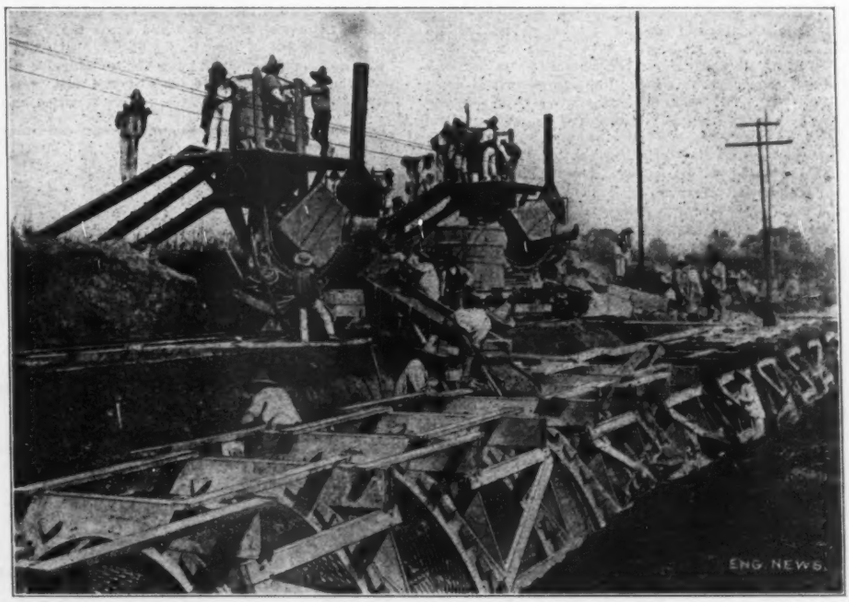


FIG. 6. MIXING AND PLACING THE CONCRETE: WATER-WORKS CONDUIT, CITY OF MEXICO.

(The blocks shown on the angle irons of the forms—in Fig. 6 and also in Figs. 1 and 2—are for the easy admission of the loose planks inserted as the work comes up. Wedges are driven between these blocks and the planks to hold the planks in place.)

A NEW VAPOR-VACUUM SYSTEM OF STEAM HEATING.*

By J. A. Donnelly.†

The system described in this paper was designed to work under the same principles as those governing mechanical circulations, where a vacuum pump is usually used upon the main return.

It was believed that if correct mechanical devices were employed a gravity return system could be made to work in a similar manner to a vacuum exhaust system and with all the advantages of the latter. Chief among these might be mentioned the doing away with the automatic air valves, that most irritating and annoying of all contrivances, which is supposed to be a necessary evil in connection with each radiator; the practicability of graduating the inlet valve to secure a partial heating of the radiator; also the advantages of running the entire system upon a vacuum or at as high a pressure as might be desired.

The system is piped exactly the same, and with the same size pipes as any ordinary two pipe dry return gravity system. All moderate sized systems are piped in this manner, and where larger systems are installed the only change is to provide additional points of air removal and run a wet return system if desired.

The hot water type of radiator is usually employed and the steam inlet is made at the top. No air valve is placed upon the radiator, as the air and water are both carried through the automatic drainage valve and down to the cellar. The water is then allowed to run to the boiler by gravity and the air removed by an automatic relief valve, located at the boiler in ordinary installations or at the foot of the riser or group of risers in large systems. The drips are sealed from the return in the usual manner, either by a loop seal or check valve.

The automatic discharge valves for the radiators are a special form of automatic impulse valve, in which the seat is made of considerably smaller area than the pipe connections. It is also at such an angle as to prevent wedging or sticking, and it will pass the ordinary dirt of the system without trouble. A cone projects from the disk of the valve into the opening of the seat and a counterweight is applied in such a manner that they both act to render the opening of the valve very gradual for increasing differences in pressure. On the disk of the valve there is placed an impact surface which is designed to materially increase the opening when water is passing.

The removal of air from the return pipe is accomplished by means of the automatic relief valve, which is acted upon by the varying pressures created in the return pipe by reason of the presence of air or steam.

With the boiler filled to the proper water line and a fire started, the action of the apparatus is as follows: Steam is generated and enters the steam main, and the friction of its flow causes a pressure in the boiler which communicates itself to the under side of the diaphragm of the relief valve and closes the air outlet. This outlet remains closed until the pressure passes into the radiators, opens the automatic discharge valves and compresses the air in the return pipes. The relief valve then opens and passes the air as fast as the combined delivery of the discharge valves. The flow continues until the air passes out of the radiators and return pipes, and the pressure in the returns is sufficiently reduced by the condensation of the steam to allow the relief valve to close.

As the automatic relief valve operates in the same manner as an air valve, it is adjusted in the same manner; the weight is pushed out upon the lever until the valve is opened and blows steam freely; when the return pipe is free of air and thoroughly heated the weight is pushed back until the flow ceases.

A lower pressure than that in the steam main is then continually maintained in the return main, the difference depending upon how much difference in pressure is required to pass the amount of steam that is condensed in the return pipes through the automatic valves upon the radiators.

If a radiator that has been shut off, is turned on, the air passes into the return through the automatic valve at the same rate, or under the same difference in pressure, as the steam through the other automatic valves. The pressure in the return then rises and opens the relief valve for the expulsion of the air.

By reducing the weight upon the relief valve a little more than is necessary to close it and just leaving it heavy enough to open when the system is cooled down, it is very easy to keep the return pipes part[ially] filled with air at all times. This air flows along the steam and collects at the relief valve ready to be discharged whenever some is introduced from a rad[iator].

Any radiator may be partially heated by [regulating the] opening of the inlet valve upon it. Steam enters and passes across the top of the radiator, water collects in the bottom until the air in the [return] is compressed, both by being reduced to small[er] volume and by heating, to equal the presssure in the return; the water then passes out and the radiator further heated until the volume of steam admitted is sufficient to cause the drainage valve to pass air as well as water.

The weight upon the automatic drainage valve is made of minimum amount, or just sufficient to lift it, and it is thus opened by a very light pressure of water.

The system is run as a vacuum system, just raising enough pressure to expel all the air, and then allowing the fire to cool until the desired amount of vacuum is obtained; the entry of air from the discharge of the relief valve being prevented by a check valve or other similar means.

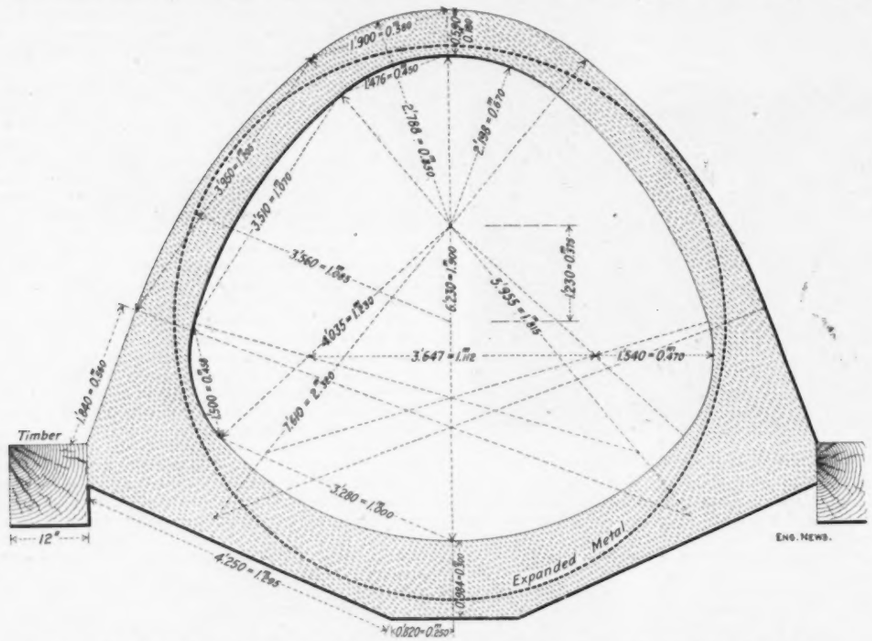


FIG. 7. SECTION OF REINFORCED CONCRETE AQUEDUCT FOR THE CITY OF MEXICO.

*A paper read before the American Society of Heating and Ventilating Engineers at its 12th annual meeting in New York City.

†Heating and Ventilating Engineer, 132 Nassau St., New York City.

THE WASHINGTON ST. TUNNEL OF THE BOSTON SUBWAY SYSTEM.

The original Boston Subway, from Haymarket Square to Pleasant St., was designed for surface street car traffic. Subsequent developments in the transit situation led to the use of the subway for elevated railway trains. This change gave a much-needed north and south elevated railway connection through the center of the city, but it resulted in a congestion of the subway accommodations that called for relief. In 1902 an act of Legislature ordered that the question of constructing a separate tunnel connection for elevated trains be submitted to the vote of the people. The vote was affirmative, and after a long discussion between the Boston Transit Commission and the elevated railway officials a route along Washington St. was decided upon. This line is shown in relation to the old subway and to the elevated railway by Fig. 1. Contracts were let and the work of construction was begun in the fall of 1904. The following report of the construction to June 30, 1905, is taken from the 1905 Report of the Boston Transit Commission. Mr. Howard Carson, Chief Engineer:

GENERAL DESCRIPTION.

Work has been in progress on the Washington St. Tunnel this season from near State St. on the north to the southern limit, not far from Oak St. The general layout of the Washington St. Tunnel is shown by Fig. 1, and the profile by Fig. 2. Of the whole length of the tunnel—according to the plan referred to 50% will be straight, 33% will have a curvature of about 5,000 ft. radius, 2% of about 1,800 ft. radius and 15% of about 500 ft. radius. The grades are as follows: Of the whole length of the tunnel 40% will be level, 7% will have a grade of less than 1% in 100 ft., 22% will have a grade of about 2% in 100 ft., 13% from ¾ to 4% in 100 ft. and about 18% of about 5% in 100 ft.

A train going north and descending into the subway will be about 48 ft. lower at Eliot St. than when on the elevated structure at Broadway. At Eliot St. the track

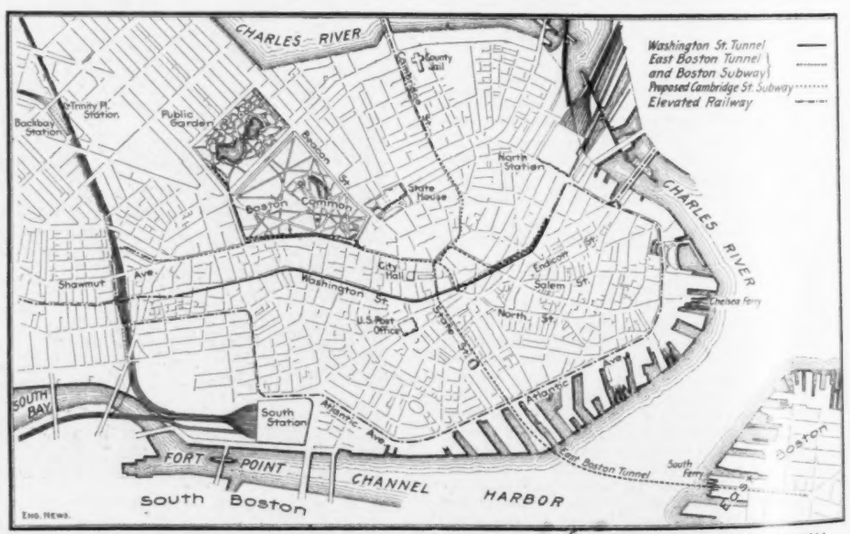


FIG. 1. MAP SHOWING NEW WASHINGTON ST. TUNNEL LINE OF THE BOSTON SUBWAY SYSTEM.

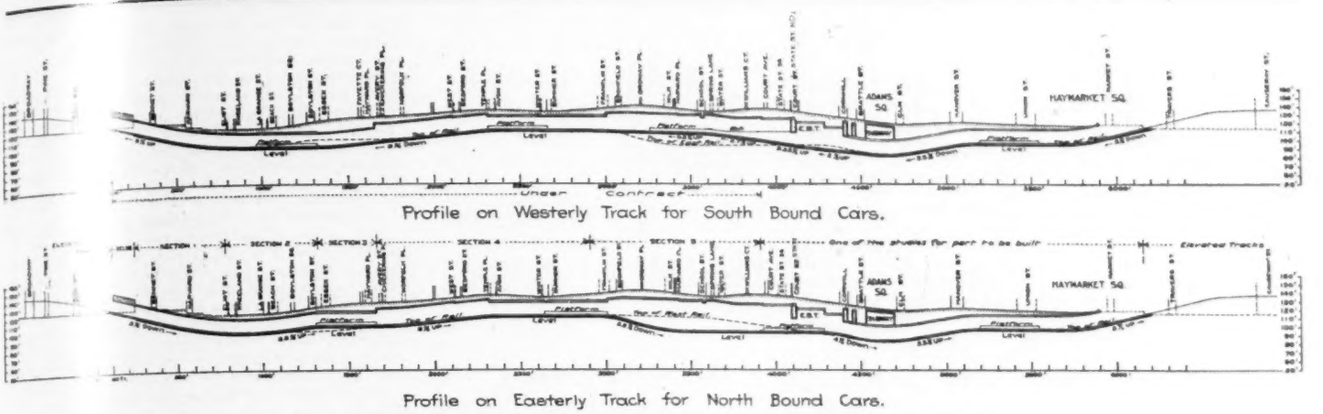

HAYMARKET SQ.
ADAMS SQ.
Under Contract
Profile on Westerly Track for South Bound Cars.
Profile on Easterly Track for North Bound Cars.

FIG. 2. PROFILES OF WASHINGTON ST. TUNNEL, BOSTON SUBWAY SYSTEM.

is about 21 ft. below the street surface and 6 ft. lower than mean low water of the sea. Continuing north the train will climb 19 ft. to Temple Pl. From Franklin St. the tracks descend and pass beneath the East Boston Tunnel at State St. at about the same level that they are under Eliot St. The lowest place in the tunnel, according to the profile shown, will be nearly under the old subway at Adams Sq., 28 ft. lower than at Franklin St. Continuing north the train will climb 52 ft. to the elevated structure at Causeway St.

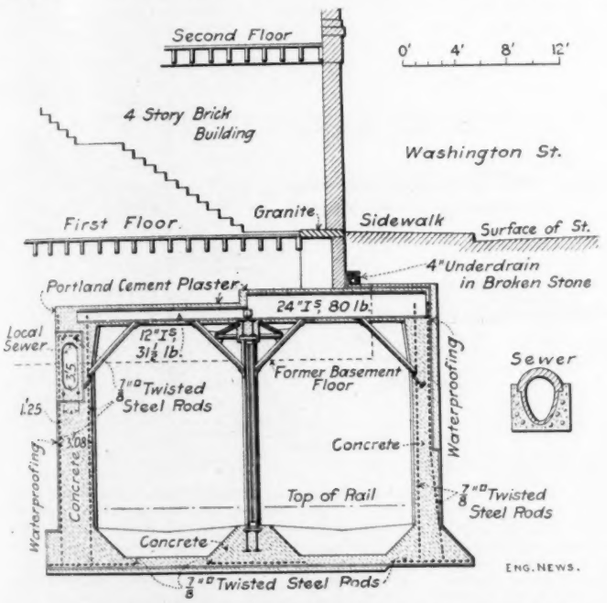


FIG. 3. WASHINGTON ST. TUNNEL CONSTRUCTION UNDER HEAVY BUILDINGS.

Cross-sectional plans of some of the work under contract are shown on Figs. 3 to 8. The character of the cross-section of the tunnel varies greatly, determined by its situation and use. South of Kneeland St., where the tunnel is wholly to the east of Washington St. and in private land, it was necessary not only adequately to support all of the existing buildings which are over the tunnel but also to provide for taller and heavier buildings which are permissible under the building laws. These conditions were best met by a heavy roof of steel beams and concrete supported by reinforced concrete side walls and by a line of steel posts between the tracks. North of Kneeland St., as will be seen from the map, "staggered" station platforms occur at frequent intervals as near the surface of the street as is practicable, and at these platforms the roof is made of steel beams and girders, with concrete arches between. Where there are no platforms, and where a considerable depth exists, the tunnel is covered by an arch with tie-rods. In all parts of the work the contingency has been provided for that the pressure of the earth may be removed on either side of the tunnel while a heavy load is being carried on top and a pressure is exerted by the earth on the other side. This provision is not usually made in masonry subways in other cities, but the conditions of narrow streets and the frequent construction of buildings with deep cellars appear to demand it here.

Little or no provision has been made for the positive ventilation of street subways constructed in other parts of the world. Adequate fans and ventilating chambers were placed in the original Boston Subway and in the East Boston Tunnel, and will be provided in the Washington St. Tunnel. In accordance with our previous methods, fresh air will in general be admitted at the stations and drawn out of the tunnel at points between stations. In some parts of the original Boston Subway the air from the tunnel was discharged through gratings in the sidewalks, but this might be objectionable on the surface of the crowded sidewalks of Washington St. Tubes will, as a rule, be used to conduct the air from points where it leaves the tunnel to the points where it will be discharged, which will usually be above the subway entrances. These tubes will in some cases be below the tunnel (see Fig. 4), and in other cases above, as illustrated on Fig. 7.

The tunnel structure in Washington St. is in no place far removed from and for most of the way comes close to the lines of the building. On account of the narrowness, crookedness and irregularity of the street and the frequency of the tunnel station platforms, the cross-section of the tunnel is very irregular and is rarely uniform for more than a few feet in length. Most of the sewer, water and gas pipes and other structures under the street required to be moved to a new position, and many service pipes are to be laid cross-wise to connect with the different buildings. For these reasons most of the earth from the pavement down to the bottom of the tunnel is necessarily taken out. The work, however, has been carried on in such a way as to interfere but little with the traffic of the street. The method of doing the work has been similar to that employed on the streets when the original subway was built. The paved surface of the street has been replaced little by little with heavy planking laid flush with the original surface of the paving and supported on timbers, and most of the work in the day time has been done under this bridging. During the night much more of the surface of the street is occupied, but nevertheless enough space is left free so that fire engines and apparatus can pass through Washington St. and in and out of any adjoining street, and this provision permits the passage of the comparatively few teams used in the night. On Sundays and holidays the street surface is occupied in places in putting down new bridging and in doing other work for which the time in a single night is too short. The street-railway cars are not diverted from Washington St. in the day time except in case of emergency, but either the north or the south bound line, or both, are often diverted at night and on Sundays.

The work has been necessarily irregular and of a piecemeal character, but the order of doing the parts has generally been somewhat as follows: Underpinning is done where necessary; side walls are built in narrow trenches, one at a time; new sewers are built in or near them; interior posts, if any, are placed in a narrow trench; the roof is put on; the core is dug out; and finally the invert is completed. During this series of operations a large number of pipes of various kinds must be supported and changed and considerable rearranging of braces and props must be made.

INCLINE NEAR ASH STREET.

The buildings where the incline is situated were taken down and their material removed by Thomas A. Elston & Co. between Sept. 8 and Oct. 6, 1904. They were mainly four-story brick structures about 60 years old. The retaining walls and roof of the incline are composed of concrete reinforced with steel rods. Above the surface of the ground the sides are open, for light and ventilation. Steel posts encased in concrete support the roof, on which is a monitor, about 8 ft. wide, open on the sides. The side walls from the floor of the incline to copings above the surface of the ground were built in monolithic sections of 20 ft. in length with expansion joints between. The roof was made continuous with a sliding joint at the junction with Section 1.

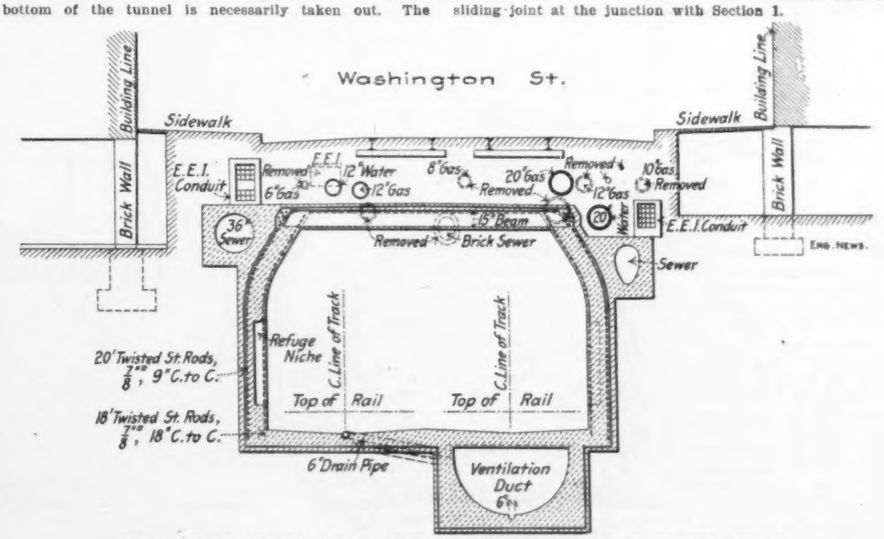


FIG. 4. WASHINGTON ST. TUNNEL CONSTRUCTION NEAR LA GRANGE ST.

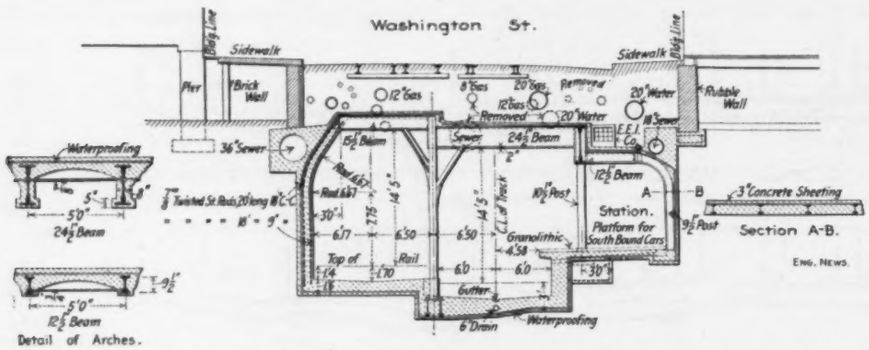


FIG. 5. WASHINGTON ST. TUNNEL CONSTRUCTION AT BOYLSTON ST. STATION.

SECTION I.

GENERAL DESCRIPTION OF STRUCTURE.—As this portion of the tunnel structure is entirely covered by buildings (except at street crossings), and as taller and heavier buildings may sooner or later, replace the present ones, the walls, roof and foundations are strongly built. The walls and invert of Section 1 are of reinforced concrete. The roof consists of steel I-beams imbedded in concrete and supported on the side walls and a row of center columns. These beams vary from 12 ins. to 24 ins. in depth and are spaced from 1 ft. to 4 ft. apart according to the loading to which they are likely to be subjected (Fig. 3).

DETAILS OF CONSTRUCTION.—The work was carried on from both ends and from shafts in Bennet and Harvard streets in sections from 12 to 20 ft. in length. In excavating the sections to the required depth, the earth was filled into tubs which were carried on small cars to the shafts, where the tubs were hoisted and dumped into carts. After the excavation was completed, the floor or invert of the tunnel was built; the side walls were next erected; then the center columns and roof beams were placed in position and riveted, after which the roof was completed with concrete which surrounds the beams and fills the space between them. The invert and side walls were made almost wholly of concrete. The concrete was mixed by a Smith rotary mixer and carried to the several openings in iron carts. The building foundations were supported on steel I-beams during construction, and then pinned up on the completed roof with brick masonry. During the excavation and construction of each short section of the tunnel, the I-beams just referred to were supported by blocking or posts resting on neighboring unexcavated earth or on the partially or wholly completed adjacent subway walls.

Generally the division walls and piers of the overhead and neighboring buildings were underpinned with brick masonry from the completed subway roof and on the sides of the subway down to an inclined plane, having an angle of 60° with a horizontal plane passing through the bottom of the side walls. Concrete sheeting was used outside the easterly wall underneath the premises, occupied by Cobb, Aldrich & Co., which sheeting was left in place. Everywhere else wooden sheeting was used, which was removed as the work progressed. The roof of the tunnel is below the street floors of buildings, except in the Sherburne Building, where it is from 3 to 5 ft. above the street floor. This story is now being remodelled. The work of supporting the buildings, constructing the tunnel, and pinning up the building foundations from the tunnel roof was necessarily slow, and took more time than was originally estimated.

SECTION II.

GENERAL DESCRIPTION OF STRUCTURE.—Where Eliot and Kneeland St. cross Washington St., for a length of 40 ft., the structure consists of a concrete invert with reinforced concrete side walls and the roof of 15-in. I-beams, 5 ft. on centers, with concrete jack arches turned between the beams. For the next 120 ft. going northerly the invert and walls are of similar construction, but the roof is of a flat arch type with 15-in. beams imbedded in the concrete every 18 ins. (Fig. 4). For the remainder of the section the invert is of concrete and the easterly wall of reinforced concrete; the westerly wall consists of steel columns spaced 5 ft. on centers surrounded with concrete; two lines of center columns carry girders extending longitudinally with the tunnel, the roof beams extending across the tunnel resting on the side walls and these girders, and between these beams, which are 5 ft. apart, concrete jack arches are turned. Where this last type is used, there is a station platform from 11 to 17 ft. in width on the westerly side of the tunnel for the accommodation of south-bound trains (Fig. 5). Approaches to this platform extend into LaGrange and Boylston Sts., distances of about 100 and 45 ft. respectively from the westerly line of Washington St. These approaches occupy practically the width of the two streets named, and have walls of steel columns imbedded in concrete, roofs of steel beams and concrete jack arches, a row of center columns and bottoms of concrete, eventually to be covered with a granolithic surface.

DETAILS OF CONSTRUCTION.—It was deemed prudent to have a portion of the side walls of the tunnel—especially where close to building foundations—done in advance of the main work of construction. A contract was made with Gow & Palmer for doing this portion of this advance work. They began operations Sept. 6, 1904, on the southerly side wall to the LaGrange St. station, opposite No. 12 LaGrange St. Four days later, work in Washington St. was begun on an opening for the pump-well at the intersection of Beach St. Work in LaGrange and Washington Sts. was prosecuted diligently by the contractors, although great care was required, particularly in the former street, where the tunnel walls were horizontally within a few inches and vertically about 10 ft. deeper than the foundations of the adjoining buildings. After reaching the depth of these foundations, excavation was carried on generally in pockets 6 ft. in length and the side wall erected therein before the intermediate pockets were excavated. In spite of the precautions taken, settlement took place on the LaGrange St. side of the building situated at the northerly corner of Washington St. To obviate settlement on the Washington St. front, the building was supported by spur-shores before operations were begun there. The foundation was then underrun in pockets about 2 ft. in width, and strengthened by a wider concrete base about 18 ins. in depth, containing 6-in. I-beams, this process being continued until the whole foundation had been strengthened. In that part of Washington St. where the side walls did not come nearer than 8 ft. to the buildings, the length of the pockets excavated was about 16 ft.

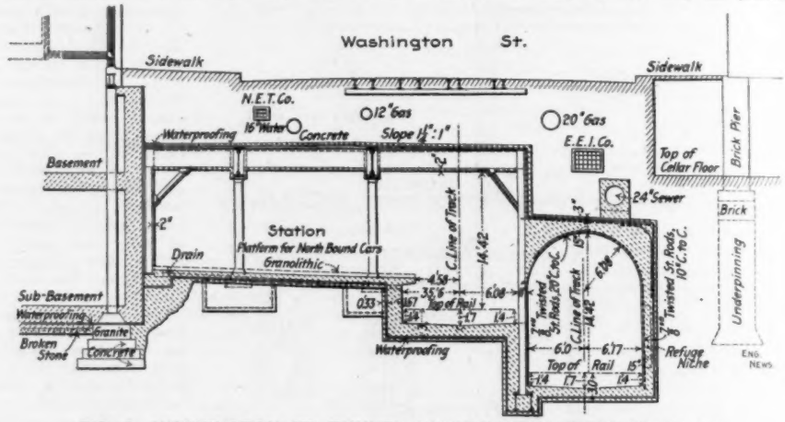


FIG. 6. WASHINGTON ST. TUNNEL CONSTRUCTION NEAR ESSEX ST.

In order to push the side walls ahead as fast as possible, a contract was also made with Coleman Brothers, and most of the side walls of the section south of the station platform were built by them. Excavation and masonry were carried on in alternate 16-ft. stretches, and new sewers at the same time built on each side of the street, the intermediate sections being built afterwards.

The Lyceum building and the Washington St. front of the building at the southerly corner of LaGrange St. were underpinned to the depth of the tunnel wall before excavation for the wall was begun. Contracts for this work were made with Isaac Blair & Co. The buildings were spur-shored and the foundations carried on steel beams. Excavation was made to the required depth, and concrete walls and piers brought up to within 18 ins. of the old foundations, the final pinning being done with brick masonry.

Work by Gow & Palmer and Coleman Brothers continued until after Patrick McGovern had started on the main contract for the section, the first-named firm finishing the work they were doing on Dec. 6 and the second on Dec. 8. Gow & Palmer had constructed about 430 ft. of side wall and sewer in Washington St. and about 180 ft. in LaGrange St., all in Section 2. Coleman Brothers had built about 170 ft. in Washington St. in Section 2 and also an adjoining strip of about 125 ft. of the westerly wall and sewer in Section 1. Contractor McGovern proceeded with the construction of the side walls and sewers where the other contractors had left off, and soon had the westerly side finished south of Boylston square, while the easterly side was practically completed to the southerly line of Boylston St. The house connections were then connected into the new sewers, and the old sewers abandoned. The work of excavating the core was then pushed ahead in LaGrange St. and that part of Washington St. where the station was located; in the former case the full width of the structure being taken, while in the latter a trench was dug first and the platform posts and roof placed, after which the remain-

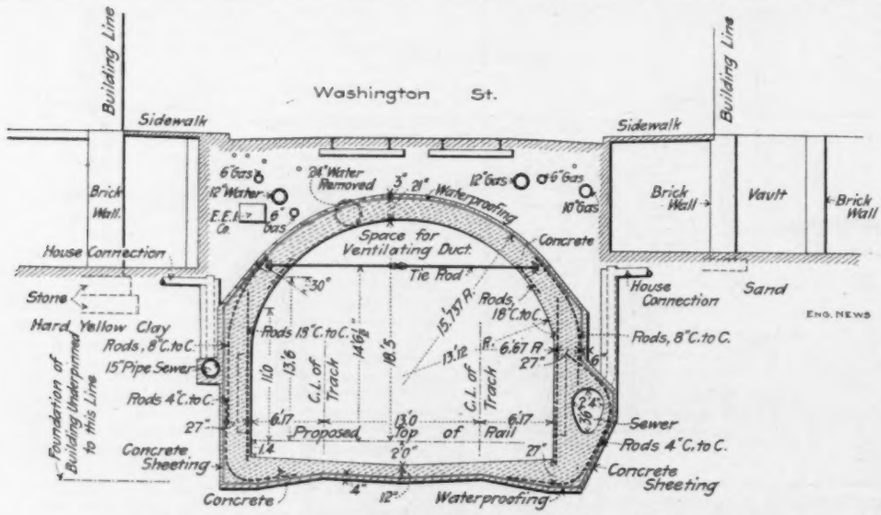


FIG. 7. WASHINGTON ST. TUNNEL CONSTRUCTION NEAR WEST ST.

ing width of the street was excavated in stretches about 40 ft. in length, the bottom concreted and the steel then erected and the roof finished.

In that part of Section 2 south of the station a different method was adopted. The street was excavated to a depth sufficient to allow the roof-beams to be set in position from the wall to side wall and the roof was finished first. The earth was then excavated underneath and the earth taken in cars to near Kneeland St., where it was hoisted through a hatch and dumped into carts. As the excavation was completed, the ventilation duct and invert were concreted in short sections.

Patrick McGovern's contract included the underpinning of the buildings at the corners of Washington and Boylston Sts—the Boylston and Shuman Buildings. The Boylston Building was underpinned by partitioning off a space about 12 ft. square about each one of the main piers successively, cutting through the piers, and supporting them by heavy steel beams put through and under them. A hole underneath was then dug of the required size and depth and heavy brick piers built up to the old piers. These brick piers were connected by a concrete wall which supported the lighter piers of the building. In the case of the Shuman Building small cross-drifts were driven under the piers, and I-beams about 20 ft. long were inserted under the foundation. Another set of I-beams parallel with and close to the front of the piers were placed above the first beams and supported at the end on timber blocking, the first beams being supported from these by iron bolts. A large box was built upon the outer ends of the lower beams and filled with paving stones, thus forming a cantilever, the weight of the building being upon the short arm. The excavation and masonry work then proceeded as usual in similar cases. The work of supporting the buildings was done by Isaac Blair & Co.

SECTION III.

GENERAL DESCRIPTION OF STRUCTURE.—The structure varies in width from 53 ft. at the northerly corner of Essex St. to 35 ft. at the northerly end of the section. The inverts are of concrete. The westerly side wall is of steel columns 5 ft. on centers surrounded by concrete. From these center columns steel I-beams cross over the easterly track to a line of girders resting on columns in the station platform. The platform girders are connected to the easterly side wall by I-beams, the easterly wall consisting of I-beam posts every 5 ft. surrounded by concrete. The spaces between the beams are spanned by concrete jack arches, the concrete being carried high enough to cover the whole structure. A cross section is shown in Fig. 6.

The platform mentioned above is from 8 ft. to 26.5 ft. in width on the easterly side of the structure and is for the use of the northerly bound trains. Approaches to these platforms extend into Essex St. and Hayward Place about 60 ft. from the easterly line of Washington St. These approaches have side walls of steel columns surrounded by concrete, steel center columns, and roofs of I-beams spanned between by small concrete arches.

DETAILS OF CONSTRUCTION.—The contract for this section included in addition to the construction of the tunnel, the tunnelling for and laying of about 600 ft. of 18-in. and 24-in. pipe sewers in Hayward Place, Harrison Ave. and Essex St. as part of the necessary sewer changes in connection with the work. The contractors began on this sewer work on Dec. 20, 1904, at the intersection of Hayward Place and Harrison Ave. Two days later, operations in Washington St. were begun in front of the store of the Pitts-Kimball Co. During the first month the work was confined to these sewers and to excavating and building the westerly wall of the tunnel where it was not very near to building foundations.

Because of the depth and proximity of the tunnel, it was deemed necessary to underpin the walls of the buildings on the westerly side of Washington St. from the northerly end of Section 2 to and including the southerly corner of the Bumstead Building, a distance of about 140 ft., and also the walls of the Arioch Wentworth Building fronting on Washington St. and Hayward Place. Excavation for this underpinning was begun in the Hotel Cecil on Jan. 20, 1905. The work of supporting the buildings was done by John Soley & Sons. The general method was to partition off a portion of the basement and to cut through the walls and piers and support the building on heavy steel beams. At the date of this report the Washington St. fronts of the buildings named have been underpinned, but work is going on under the Hayward Place front of the Arioch Wentworth Building.

The general method in Washington St. after the building foundations have been underpinned has been to build the westerly wall of the tunnel to the height of the springing line of the arch, and then to excavate for and build the center wall to the springing line, after which the arch is turned. At this writing the westerly wall is practically all built to the springing line, but only 85 ft. of the center wall and arch have been built. On the easterly side of the street the columns have been set in position, but the concreting is not yet completed.

SECTION IV.

GENERAL DESCRIPTION OF STRUCTURE.—From the southerly end of the section to Temple Place the structure consists of a concrete invert, reinforced concrete side walls and a concrete arch with steel tie rods of 2.25 ins. diameter spaced about 2.5 ft. apart. A cross section is shown by Fig. 7. Between Temple Place and Winter St. there is a platform on the westerly side of the street for south-bound cars, which is about 350 ft. long and from 16 to 17 ft. wide. The cross section of this platform is shown by Fig. 8. From Winter St. north there is a platform on the easterly side of the street for north-bound trains. This platform has about the same length and width as the other.

North of Temple Place the roof of the structure is composed of steel roof beams placed 5 ft. on centers, with concrete arches between them. Between Temple Place and Winter St. the roof beams are supported by reinforced concrete walls and two lines of steel columns. North of Winter St. the structure differs from the above in that steel columns are placed in the easterly concrete wall and the roof beams are riveted to them.

UNDERPINNING OF BUILDINGS.—Owing to the proximity of the subway walls to the buildings, it was decided to underpin about three-fourths of all the buildings along the line of this section. The foundations of these buildings were carried down to the same depth as the bottom of the subway. The work of supporting the buildings while this underpinning was going on was sub-let by the general contractor mainly to the John Cavanaugh & Son Building Moving Co., and in part to Gow & Palmer. The careful levels taken on these buildings showed no settlement greater than ⅛ in., and that in two cases only.

DETAILS OF CONSTRUCTION.—As the new tunnel displaces the old sewer, it was necessary to build the side walls and the new sewers and to turn the flow of the sewage into these sewers in advance of much of the work in the center of the street. Work on this section was commenced on Feb. 21, and has been pushed vigorously. Under the provisions of contract, the contractor was not allowed to remove excavated material south of Winter St. between 7.45 a. m. and 6.15 p. m. except on Sundays and holidays. This required the greater part of the excavation to be done at night. The progress of the work indicates that the completion of the section may be expected somewhat in advance of the time set in the contract.

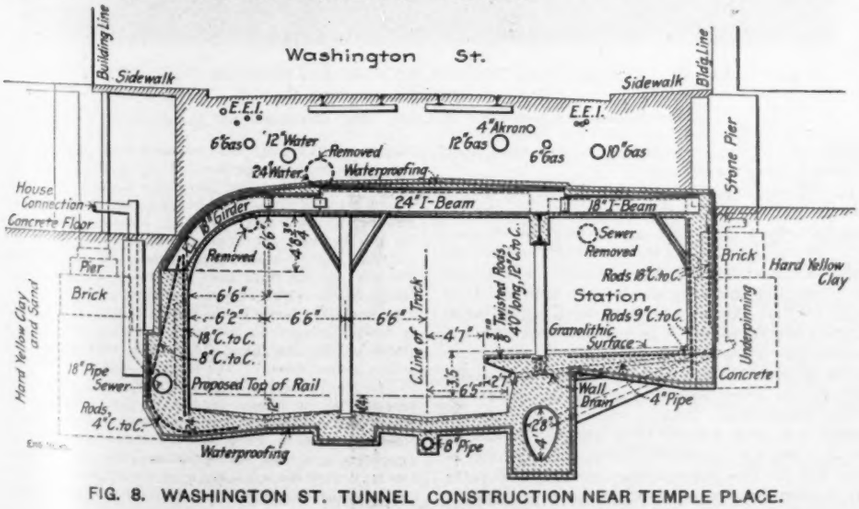


FIG. 8. WASHINGTON ST. TUNNEL CONSTRUCTION NEAR TEMPLE PLACE.

SECTION V.

GENERAL DESCRIPTION OF STRUCTURE.—The structure will in general consist of concrete invert, side walls of reinforced concrete and an arch roof with tie rods. For a length of 100 ft. south of and across Franklin St., however, the roof will be constructed of 20-in. and 24-in. I-beams imbedded in concrete and supported by girders carried on two lines of steel columns. Steel columns are also placed 5 ft. apart in the easterly side wall the same as in the adjoining portion of Section 4.

DETAILS OF CONSTRUCTION.—The side walls between Franklin and Milk Sts. are now under construction, the work being carried on in lengths of about 16 ft. No excavation has as yet been done (June 30th) north of Milk St.

Section 5 is deeper than the preceding sections, the bottom being from 30 to 48 ft. below the street. A feature of interest is that the track for north-bound cars from about 90 ft. south of Milk St. to the northerly end of the section is under the platform for south-bound cars and the passage-way leading to the State St. entrance to the tunnel. From the middle of the Herald Building northerly for a distance of about 110 ft. the westerly wall of the tunnel is under the front walls of buildings.

COMMON SOURCES OF ERROR IN FIELD WORK.*

By A. M. Shaw,† Assoc. M. Am. Soc. C. E.

The following sources of error and their suggested remedies are such as have occurred in the writer's experience and the practice recommended will result in such a degree of precision as is usually desired on railway surveys.

1. Lack of Adjustment of Instruments.—Little trouble is now experienced with lack of adjustment of chains and the matter of adjusting transits and levels is fully treated in instrument catalogues and other books.

2. Inaccurate Chaining.—At the beginning of a survey, have a well defined method of checking the measurements and numbering the stakes and then insist on the system being adhered to. This system should be such that each chainman, and if possible the stake artist, will know of his own knowledge, that each stake is properly set and marked. As an additional check, the level party, if there is one, should check all full stations. In "breaking chain," each full station should be roughly checked from the preceding station by a measurement made with the full length chain.

3. Errors in Reading the Vernier.—Always carry your calculated bearing from the original course as the survey progresses, checking this at least once on each course with the needle reading. Where a considerable degree of accuracy is desired, repeat each angle.

4. Local Attraction of Needle.—Look out for steel adjusting pins, knives, axes, wire fences, car trucks, etc. Excepting in the most unimportant work, use the needle only as a rough check on the readings from the vernier plates.

5. Unstable Fore and Back Sights.—Remember that a slender stick with a paper in the top may bend in a breeze and even a telephone pole with an enticingly pointed top may wabble in a stiff wind.

6. Soft Ground Causing an Unstable "Set Up."—Force the legs of the tripod into a good depth and, if necessary, use snow pads to give a bearing for the extremities of the tripod. In very unstable ground have an assistant to take the back sights so that the instrument may not be disturbed by the shifting weight of the instrumentman. The writer recalls running a line through a "muskeg" swamp where it was necessary to set the instrument so that the telescope was only about 18 ins. above the icy ooze. The instrumentman and an assistant were each seated on gradually submerging pieces of bark, with legs interlocked and the instrument between so that sights could be taken in either direction without shifting position.

7. Loose Screws at Top of Tripod.—A good test is to raise each tripod leg separately. If it drops from its own weight, the screws are too loose.

8. Loose shoes on tripod.—Use common sense and a screw driver.

9. Plumb bob not hanging true.—This may be caused by the string catching on a thumb nut of the tripod head or from a bent wire hanger. Replace the wire hanger with a fine chain.

10. Movement in Lower Limb of Transit while Turning an Angle or Vice Versa.—Keep all movements so that they will turn easily when not clamped and in setting clamps, see that they are brought to a firm bearing. If compelled to turn an angle with an instrument that does not turn easily, place the fingers of one hand on the edges of moveable and stationary parts in the lower part of the instrument so that you will detect any movement. Repeat the angle as an additional precaution. Remove the cause at the first opportunity. It will usually be possible to do this by cleaning the joint thoroughly and lubricating with a very little watch oil. In an emergency a light oil may be prepared by mixing kero-

*Extract from a paper prepared for the engineering students of Cornell College, Mt. Vernon, Iowa.

†Dixon, Ill.

sene with any good heavy oil available, but this should be replaced as soon as practicable.

12. Error in Rod Readings.—I find that with self-reading rods the following system will practically eliminate chance of serious error. In taking turning points, the levelman should take a reading to hundredths, calling the reading to the rodman, who will set the target and place rod for a second sight. While the rodman is setting the target, the levelman should see that his instrument is level. While the second sight is being taken, the rodman should slowly wave the rod toward and from the instrument to insure the correct setting of the target for a vertical position of the rod. After the position of the target has been verified or corrected, the rodman calls the reading, each man recording at once. The rodman should carry a peg book showing all turning points and bench marks and as many other prominent or important points as his duties will permit. Both men should keep the elevations of all turning points calculated as the work progresses and should compare frequently. In addition to its being a check on the reading of the target, the method of first reading the rod direct results in much saving of time in setting the target, though it may be necessary at times, to set the target by signals.

13. Mistaking a Wire for a Cross Hair.—I have known this to occur twice, and in each case the deception was perfect. The only safeguard is to be very wary when a wire fence or telephone line comes in your line of vision.

RAIL SHIPMENT OF VERY LARGE CASTINGS or other articles of exceptional weight and size is a problem which occasionally arises, particularly in connection with heavy machine construction. A record shipment recently made in England was the cast-steel stern frame and brackets for the two new Cunard vessels which are to be the largest vessels by far ever constructed. The castings were made at Wallsend-on-Tyne at the works of Messrs. Swan, Hunter & Wigham-Richardson, Ltd., and had to be transported by rail to the shipbuilding yards of John Brown & Co., Clydebank. The manner in which the shipment was made is described as follows in the "Iron and Coal Trades Review":

Although the stern frame was loaded upon a specially-designed 50-ton car, its dimensions were of such exceptional size as to largely exceed the British railway loading gage, and it was found impracticable to convey the main stern post by railway from Darlington to either Clydebank or to Wallsend-on-Tyne, the only alternative being to convey the articles to Middlesbrough to be there shipped by special steamer at Messrs. Richardsons, Westgarth & Company's shear legs. Taking advantage of the lull in ordinary traffic, the stern posts were successfully conveyed over the Northeastern Ry. Co.'s lines from Darlington to Middlesbrough on two recent Sundays. Having regard to the unusual weight and dimensions of the articles, a maximum speed of three miles per hour was observed, and the adjoining tracks on both sides were reserved for the entire stretch from Darlington to the shipping point, to admit of the safe passage of the "stern frame special." The total length of the stern post, as loaded upon the car, was 31 ft. 6 ins. over all, the maximum width being 16 ft. 4½ ins., and the distance from rail level to top of load 13 ft. 4 ins. The "wing" of the frame overlapped the car side by 9 ft., while, on the abutment side, the load projected 3 ft. 6 ins., the overhang being counterbalanced by heavy steel ingots. For use in case of emergency two mammoth steam traveling cranes formed a portion of this unique railway train, and these were requisitioned on arrival of the train in the Middlesbrough goods yard in order to shift the position of the stern post, so as to admit of its safe passage into the siding at the shear legs. The "stern frame special" left Darlington at 10 o'clock in the morning on both occasions, and Middlesbrough was safely reached shortly before 4 o'clock in the afternoon.

We do not recall any other case where a railway has moved a load so large as to require stopping traffic on tracks on both sides of the one used.

A NEW TRENCHING MACHINE.

A trench excavating machine with toothed cutting-edge buckets mounted on an endless chain working over sprocket wheels, the whole raised and lowered by a vertical digger handle, is illustrated herewith. The view shows the dirt being discharged at one side, but if desired it can be carried to the rear by an endless belt and dumped for back-filling. Theoretically there is no limit to the depth of trench which can be dug with this machine, but practically the depth is limited by the necessity of keeping the digger handle short enough so it will not be top-heavy when raised to its full height, as when starting to dig a trench. It is believed that a 30-ft. trench could be excavated by a machine similar in principle to the one pictured herewith. The trench width may be varied from 24 to 36 ins. by changing the buckets with No. 1 machine, and 3 ft. 6 ins. to 6 ft. with No. 2 machine.

The machine shown by the view, Fig. 1, was the first, and thus far is the only one, built. With it a trench 30 ins. wide, 19 ft. deep and 560 ft. long was dug at St. Louis, Mo. On this work 30 cu. yds. of dirt per hour were removed and up to 70 lin. ft. of trench per day were dug. The material encountered was stiff, wet, yellow clay, with 3 ft. of fire clay and a stratum of gravel and small boulders at the bottom.

The manufacturers of the apparatus, the Helm Trench Machine Co., 4223 Louisiana Ave., St. Louis, Mo., are now building a new machine, involving some improvements over the old one, including a steel in place of a wood frame. The digger handle on the machine shown in the view is 26 ft. in length, out to out of sprocket wheels. This permits a cut 12 ft. deep or less. An extension of 8 ft., permitting a corresponding increase in depth, was made to dig the 19-ft. trench already mentioned.

In the new machine now being built the digger handle will have a normal length of about 28 ft., out to out of sprockets, permitting an excavation 10 ft. deep; that is, there will always be 18 ft. of digger handle above ground. For deeper trenches the digger handle will be spliced. It is believed that this can be done with safety until a total length of 48 ft. is reached, allowing excavation to a depth of 30 ft.

The new machine will be provided with a 38-HP. Scotch boiler and an 8¼ × 10-in. duplex reverse link-motion engine, built on a self-contained cast-iron frame. The general design of the new machine is shown by the plan and elevation, Fig. 2. The power from the engine actuates the various parts of the machine through a crank shaft, as may be seen by referri[illegible] the plan and elevation.

The operation of the machine may [illegible]stood by the aid of the illustrations, with the following description, submitt[illegible] John Helm:

To operate the machine the sprocket clut[illegible] engaged by a square jaw clutch. Power is [illegible]on. The crank shaft pinion drives the [illegible] the gear and sprocket wheel shaft. The spr[illegible] wheel on last-named shaft drives the [illegible] sprocket wheel on top of the frame, by m[illegible] chain drive. This, in turn, drives the convey[illegible] wheels which drive the endless chain and [illegible]

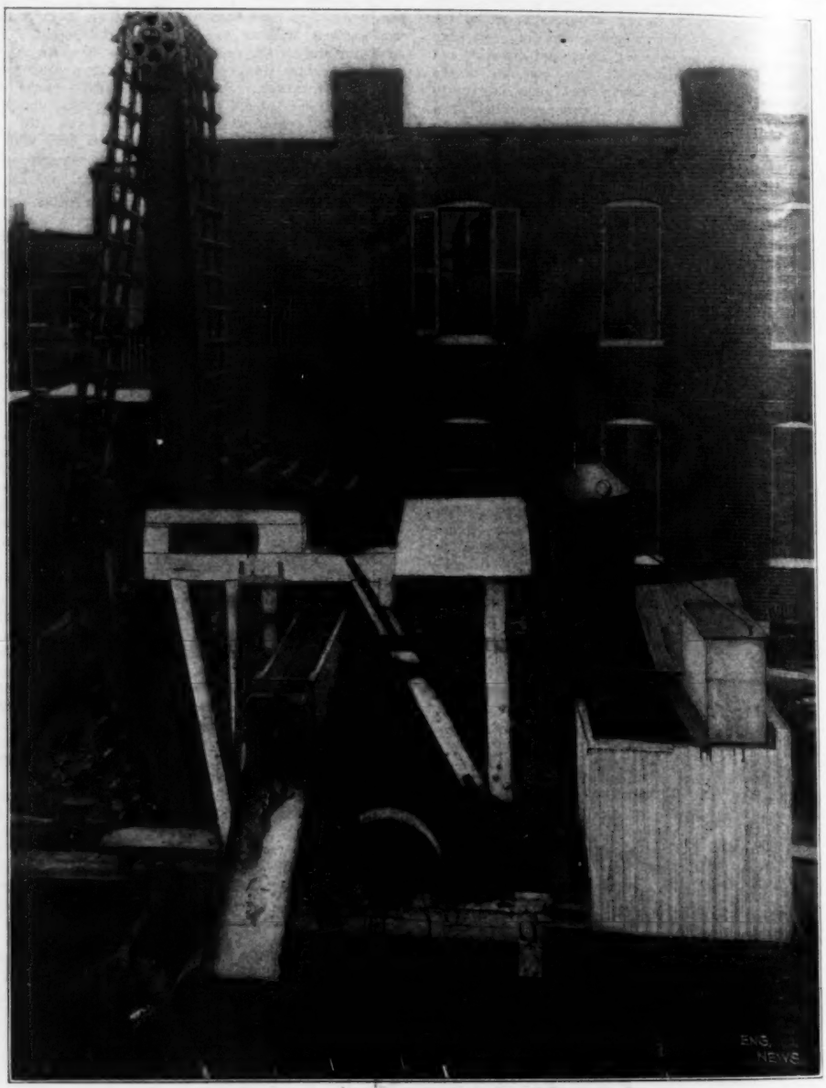


FIG. 1. VIEW OF EXPERIMENTAL TRENCH EXCAVATING MACHINE IN POSITION FOR WORK.

Helm Trench Machine Co., St. Louis, Mo., Designers and Builders.

diggers continuously. The operator then takes in hand the brake lever on the hoist drum, throws off the dog on the drum ratchet, and lowers the digger handle to required depth of trench, the buckets running continuously and digging their own way down, when the dog engages the ratchet again and keeps the digger handle in a fixed position. To raise the digger handle the operator uses the lever on the right hand side for operating the umbrella clutch, which engages the hoist drum.

After digging down to the required depth the machine is moved forward by the lever operating the umbrella clutch on the left hand side, which engages the propelling pinion driver. The machine moves forward until the four tension springs fastened to the lower guide bearings of the digger handle are opened about 1 ft. These four springs are then pulling the bucket with a pressure of two or more tons against the work to face. After digging a little the tension gets less, and the operator must work the operating lever (on left hand side) thus engaging the propelling pinion driver and moving for-

ward ag... In fact, after the digg... down to the required ... the operator must ke... lever (for umbrella ... engaging propelling ... driver) in hand and dr... machine practically ... uously forward, keeping ... train on the tension ... The harder the ground ... greater the required ... on the tension springs. The machine is geared ... travel about two miles ... hour. The low speed of the buckets is 100 ft. per min... and with buckets 2 ft. wide the digging capacity ... the machine is 66 cu. yds. per hour; with a speed of ... ft. per min. the digging capacity is 99 cu. yds. The wider the buckets, obviously, the greater the capacity of the machine. A No. 1 machine will dig any width of trench from 24 to 36 ins. wide by changing the buckets, and No. 2 machine likewise can be made to dig any width from 3½ to 6 ft. By using center links any desired width of trench can be dug up to the limit of the machine getting too unwieldy.

The buckets on the endless chain discharge into the trough or drag conveyor, from which the dirt may be dumped at the side of the trench; or, by opening a slide in the end of the drag conveyor the dirt may be emptied onto the belt conveyor and discharged into the trench at the rear for back-filling. The belt conveyor is designed to travel at the rate of 600 ft. per min. The bucket chain may be tightened by take-up arrangements placed at the top and bottom sprocket wheels. The digger handle is held up to the face of the excavation, and at the same time given flexibility to pass over obstructions, by the two springs at each side of the digger handle at the bottom of the sills. The chain and buckets (Fig. 3) are of 8-in. pitch.

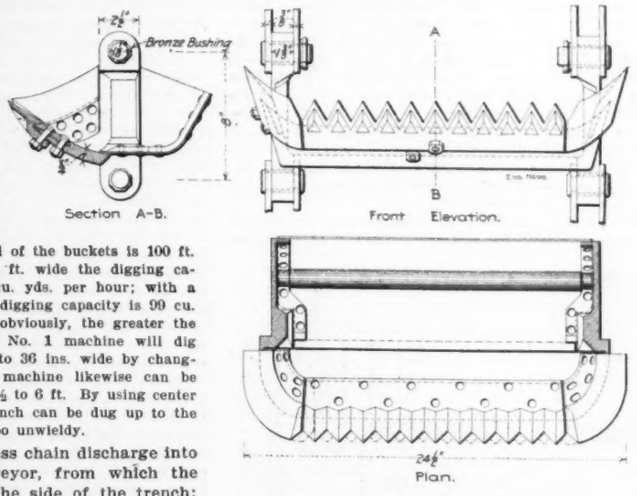


Fig. 3. Bucket for New Style Trench Excavating Machine.

Some of the claims for this trenching machine, as submitted by the builders, may be summarized as follows: Great possible depth of excavation; vertical cut permits bracing within 4 ft. of working face; cutting edge of buckets extends only 5½ ins. beyond chain, thus lessening strain and decreasing necessary weight; ease with which obstruction, like rock, is passed over, owing to provision of springs, already mentioned, and, when obstruction is too large to be passed over by yield of springs, ready means of lifting the digger handle so buckets can pass over obstruction; vertical working face and design of buckets causes latter to be filled by slight scraping of the dirt, never in excess of 1 in. in depth, thus avoiding friction of dragging of whole bucket through the dirt; machine operated by one engineer, one fireman and one laborer, and with 30 HP.; small amount of vibration and noise.

CONCRETE PAVING is being used for alleys at Denver, Colo., and also for the tracks of the street railways, being laid between the rails and for a width of 2 ft. outside. The concrete is 6 ins. thick, with a bottom course of 1:3:7 and a top course of 1:2:4. The Denver City Tramways Co. first adopted this, at the suggestion of Mr. C. A. Trease, Chief Engineer; it uses a 3-in. bottom course of gravel concrete, and a 3-in. upper course of basalt concrete, the latter being laid while the former is wet. For the alleys, the city uses a 3-in. bed of cinders or gravel, wetted and rolled; then a 4-in. bed of the leaner concrete and a 2-in. bed of the richer concrete. Both beds are of gravel concrete, and are laid to form one mass. A single 6-in. bed of 1:2:4 concrete is proposed for future work.

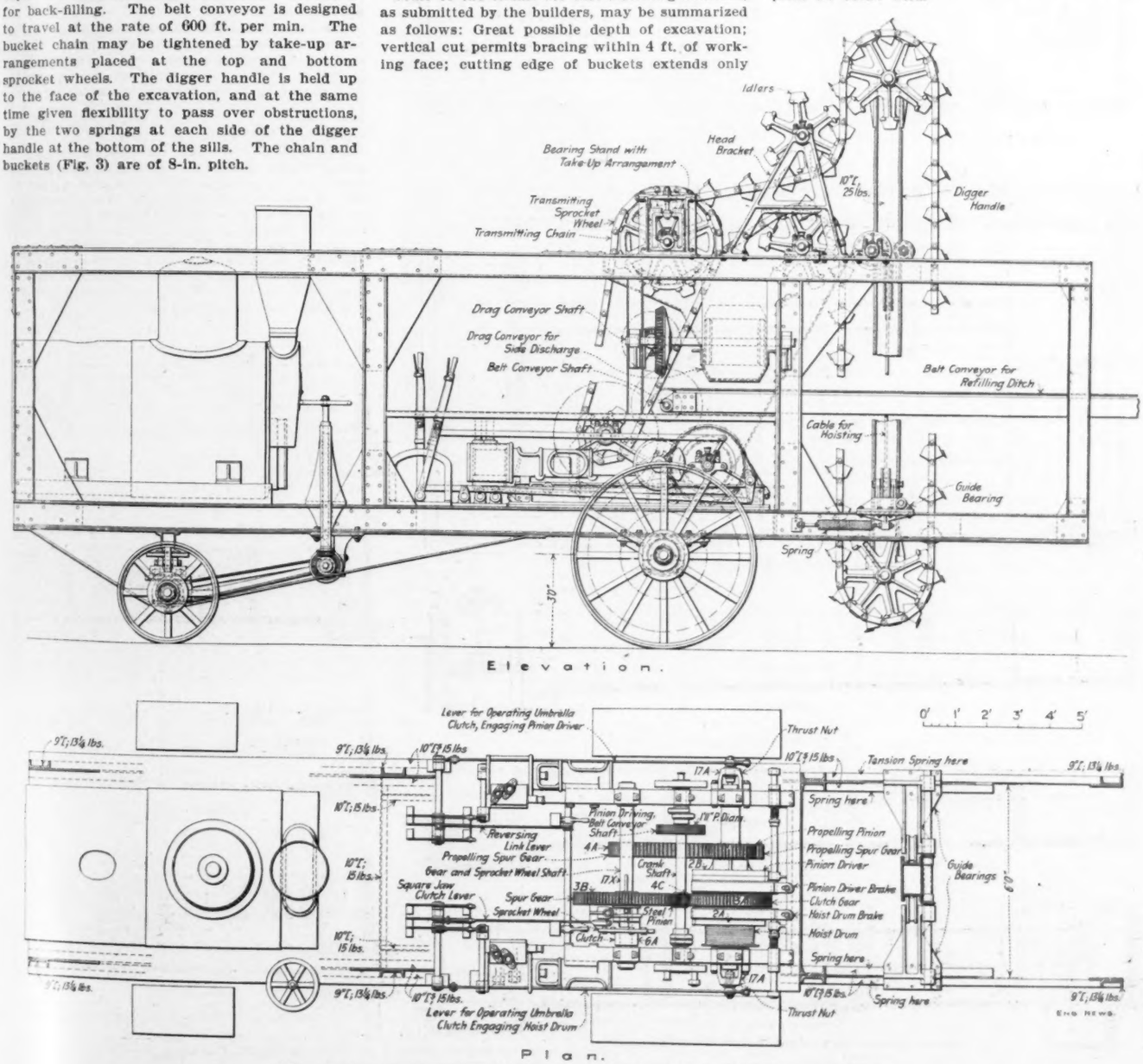


FIG. 2. PLAN AND ELEVATION OF NEW STYLE TRENCH EXCAVATING MACHINE.

THE NEW HYDRAULIC LABORATORY AT THE UNIVERSITY OF WISCONSIN.*

By D. W. Mead.†

The new hydraulic laboratory at the University of Wisconsin [now nearly completed—Ed.] is located on the shore of Lake Mendota, which borders the university campus on the north and immediately adjoins the university pumping station and tank house. In this location an unlimited quantity of water is available for hydraulic experiments under low heads, and high heads up to about 170 ft. are provided for by the university water-works pressure storage tanks. The bluffs of the lake at this point are about 50 ft. above the lake level, affording a site for a storage reservoir for moderate heads, which, while not yet constructed, is one of the accessories which it is intended to add in the near future.

The foundation, basement, walls, columns and floor of the laboratory building are constructed of reinforced concrete. The walls of the building above the basement are of concrete blocks and the roof is an open truss type covered with red tile roofing.

The building consists of three stories, each 48 × 98 ft. in plan, including the basement, which is placed about 18 ins. above the water level of the lake. In one corner of this basement is located an engine room, containing a large pumping engine installed for the purpose of furnishing large quantities of water under low heads for large flow, weir and water power experiments. This pump consists of a Morris centrifugal pump, direct connected to vertical twin engines and with a single 30-in. suction and 30-in. discharge, located and arranged as shown in the illustrations. This pump takes its supply from a 10-ft. canal leading directly from the lake and of a sufficient depth to provide for the flow of water when the lake is frozen over. The pump delivers the water into a receiving chamber of considerable size from which it may be taken for purposes of various experiments under heads up to 10 ft. With this chamber are connected various conduits and channels by means of which investigations can be made on a scale of considerable magnitude concerning the laws of flow in such channels and conduits, together with the effect thereon of the presence of dams, weirs, racks, submerged orifices and other features encountered in water power work.

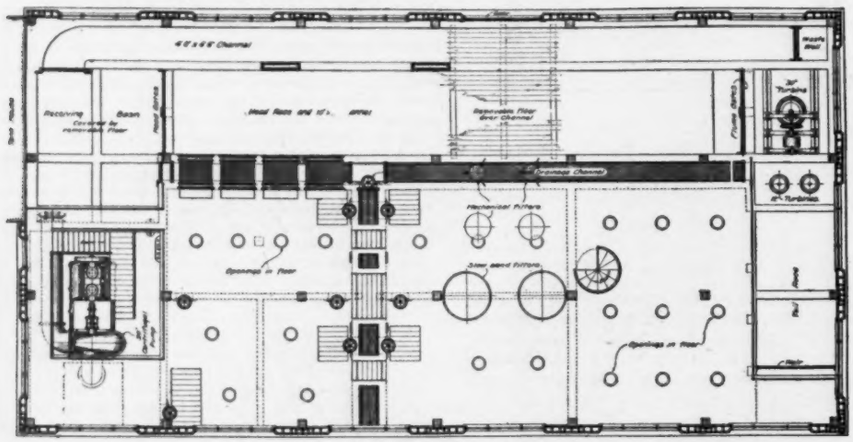
The receiving chamber is connected by double head gates with a channel or race-way 10 ft. in width and 10 ft. in depth, which is intended to serve for large flow experiments, and also as a head race leading to the larger turbine installation. In this channel flow measurements may be made with various depths of water in the channel as constructed, or with varying depths and widths by the temporary restriction of its cross-section. The volume of water available, which will be from 25,000 to 35,000 gals. per min., offers a considerable opportunity for research work with reference to large apertures, weirs and racks.

In addition to this large channel, a small channel has been constructed, 4 ft. in width and 4½ ft. in depth, parallel and adjoining the former on the south. This will be used in connection with various channel experiments on a smaller scale, and also for the purpose of rating current meters and pitot tubes. Below this channel is a 30-in. circular concrete conduit where the phenomena of flow in closed channels may be observed.

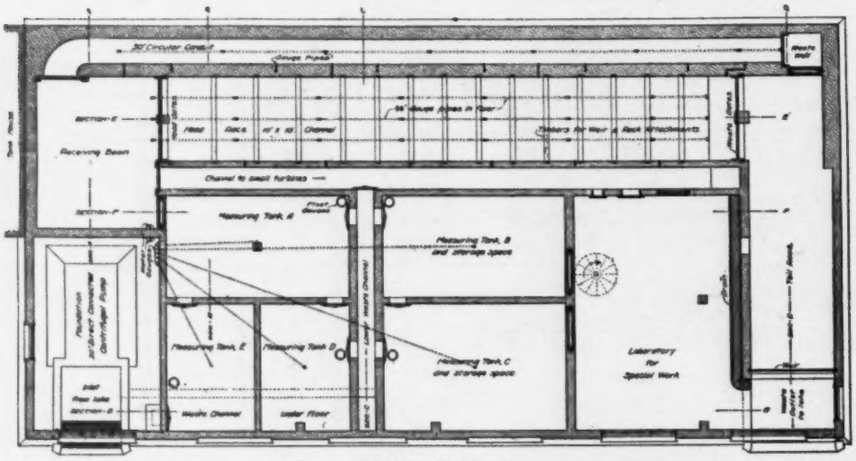
In addition to these permanent concrete channels a smaller wooden channel for similar purposes has been constructed and placed on the main floor of the laboratory. A weir box at the head of this channel discharges into the same, giving a measured quantity of water from which the relations of channel flow are obtained. The gradient of the channel is readily adjustable and the relations of volume, section and gradient can be varied, thus providing conditions more satisfactory for instructional work than with the large channels, but not of as much value for advanced and research work.

*Slightly condensed from "The Wisconsin Engineer" for March, 1900.

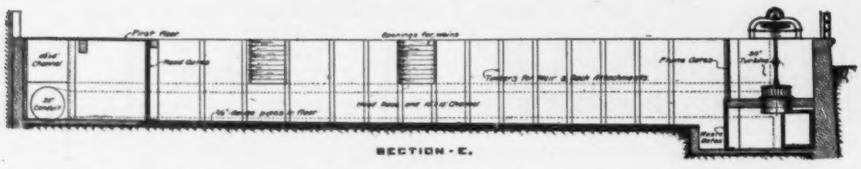
†Professor of Hydraulic and Sanitary Engineering, University of Wisconsin, Madison, Wis.



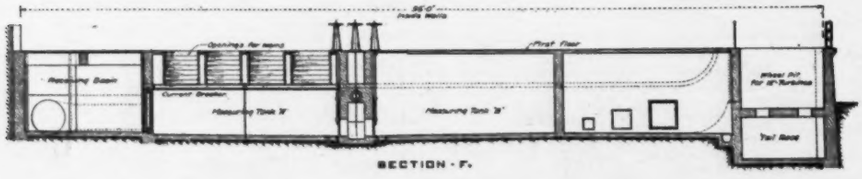
FIRST FLOOR PLAN.



BASEMENT PLAN.



SECTION - E.



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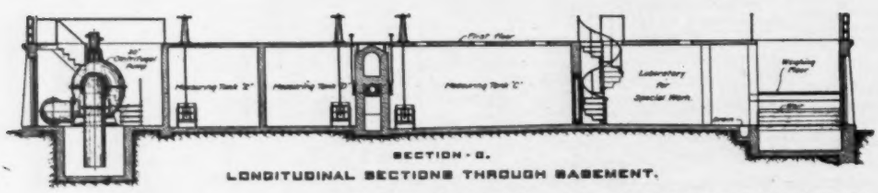
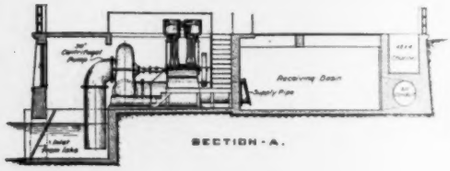
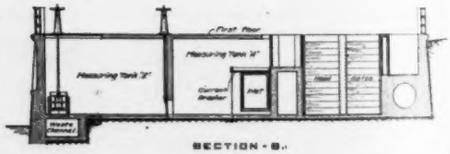


SECTION - G.

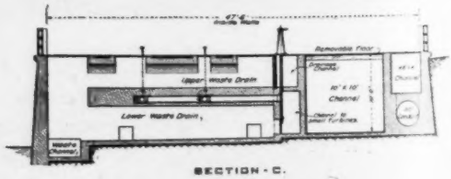
LONGITUDINAL SECTIONS THROUGH BASEMENT.



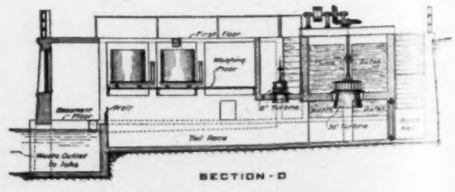
SECTION - A.



SECTION - B.



SECTION - C.



SECTION - D

SECTIONS THROUGH BASEMENT

0' 5' 10' 15' 20'

THE NEW HYDRAULIC LABORATORY OF THE UNIVERSITY OF WISCONSIN.

In the basement have been constructed five measuring chambers. These chambers are arranged so that they can be operated independently, or together in two groups. In the possible grouping of the chambers each group will contain about 5,000 cu. ft. It is intended to use these measuring tanks in experiments where measurements of a high degree of accuracy are desired of considerable quantities of water. Their capacity will be carefully calibrated between definite points, which will be accurately determined by hook gages. In the volumetric measurement large discharges of water will be allowed to flow into a chamber or group of chambers until it or they are practically filled, then by closing one valve and opening another the discharge will be directed into another chamber or group of chambers while the first is being emptied. By this means experiments can be carried on for an unlimited period of time, and the errors of limited observations thus obviated. By means of proper floor openings these chambers can also be used as suction pits for pump experiments, when desired.

One group of measuring chambers is so arranged that they may be utilized for storage or experimental space when not desired for the purpose of measurements. They can be readily opened for such purposes, or closed and utilized for volumetric measurements.

In addition to these large permanent measuring chambers, movable tanks and scales are provided for the measurement of water by weight, for use in smaller experiments. There are also provided various similar movable measuring tanks for the smaller volumetric observations.

Various weir boxes have been provided for the determination of weir conditions and weir constants. These are arranged to discharge into the measuring chambers in the basement, by means of which an accurate determination of the quantity of water flowing in a given time can be made. The weirs can be varied, with a range up to 26 ins. in width and for heads as high as 18 ins. In addition to the simple weir boxes there is also provided a double weir box for the investigation of the relations between various shapes of weirs and between free and submerged weirs. A fixed weir is constructed at the central partition, and may be duplicated in form at the lower end of the partition in a movable weir. By raising the end weir any degree of submergence within the range of the apparatus can be obtained in the center weir, and the effect of submergence on the discharge determined by proper comparisons. In addition to this, weirs or other openings of various shapes can be compared by using one of each kind in the two weir openings and observing the relations of the depth of water over each under uniform flow. A second combination of tank and weir boxes gives an opportunity to measure the losses in submerged orifices, and compare the flow with the flow of a standard weir over which the water passes after the orifice is passed. For weirs up to 26 ins. in width and 18 ins. in depth it is designed to make careful volumetric observations of relative discharge under varying head. For larger weirs and weirs of various arrangements of breadth and section, experiments will be made in the main 10-ft. channel. By admitting the water from the receiving chamber through a movable partition into measuring chamber A, the water may be passed over a number of standard weirs of smaller size, such as have previously been standardized volumetrically in the upper laboratory. By this means accurate determination can be made of the discharge of weirs of considerable magnitude in the main channel. It is also designed to arrange for experiments of considerable magnitude on the flow of water through submerged orifices and various forms of short conduits, such as are used in water power work. Studies will also be made of the effects of racks and other obstructions to the flow of water in this large channel.

Four turbines have been purchased, the largest of which, a 30-in. wheel, will develop about 50 HP. under the maximum available head. This turbine is located at the west end of the 10-ft. channel, from which it receives its water supply. The water, after passing the wheel, is discharged into a tail race 10 ft. in width, and in which a 5-ft. depth of flow will be maintained. In this tail race is arranged a standard weir. This weir, in connection with a prony brake on the wheel, will permit of the accurate determination of quantities, velocities and efficiencies under various heads and conditions.

The smaller turbines are set in a separate wheel pit and receive their waters through a separate channel, discharging, however, at the present time into the same tail race as the larger turbine.

East of the hydraulic laboratory, directly connected with it and forming an integral part of the plant, are the University tank and pump houses. The pump-house is equipped at present with one crank and fly-wheel compound condensing pumping engine, one compound direct acting duplex steam pump and one high pressure duplex steam pump. This station is soon to be reconstructed, greatly increased in size and provided with more modern machinery. The pumps deliver their water into the university mains, the excess being stored in the storage tanks under 78 lbs. pressure. This pressure is maintained constant, both with and without the pumps, by air pressure from two air tanks, which contain air at a higher pressure (100 to 150 lbs.). These storage tanks furnish water under the higher pressures needed for many experimental purposes.

From these tanks are operated two types of tangential wheels and a Girard turbine, besides several small water motors, and other apparatus for experimental work under high heads.

The air tanks and the compressor that supply them are also to be utilized for experimental study on the air lift and other types of pneumatic pumps.

The laboratory is provided with two hydraulic rams. A No. 20 Rife ram which is in use for general experimental purposes is provided with a 2-in. drive pipe which is arranged in 6-ft. sections. The supply tank to the ram is adjustable and can be so arranged that it will supply water to the ram under heads varying from 18 ins. to 10 ft. This variation in head and length of drive pipe, together with the variation in the pressure of discharge, gives a considerable range for experimental work and provisions are made for the accurate determination of the effects of such variations on efficiency and service. A new ram has been especially designed for experimental purposes and will be installed in the near future. In this ram arrangements will be made for variations in valve area, valve lift, air chamber capacity, etc., for the purpose of a detailed study of efficiencies under considerably greater heads and greater length of drive pipe than are now available. The new ram will also be arranged for

H. W. Parkhurst.

4-in. drive pipe, placing the experiments on a larger and more satisfactory scale. A smaller ram is provided capable of being worked under supply heads up to 50 lbs. pressure, but with smaller quantities of water.

Two tanks are provided for the determination of the friction of water flowing through sand and gravel. Plans have also been matured for the construction of a larger sand tank by means of which the laws of the flow of ground water through sands and soils and the principle controlling the operation of wells can be studied.

In connection with the hydraulic and sanitary work, there has been provided in the laboratory four water filters. Two of these filters are slow sand filters and consist of tanks 6 ft. in diameter by 8 ft. in height. In addition to these, one Jewell gravity filter has been purchased, and one mechanical filter containing Norwood strainers has been furnished and presented to the university by the Norwood Engineering Co. These filters have been fully equipped for experimental work.

Apparatus has been provided for the study of the flow of water in straight and curved pipes and hose of various sizes and materials, also for the investigation of losses due to sudden expansion and contraction and to valves and other forms of restricted passages. The laboratory is also supplied with various reciprocating pumps, centrifugal pumps, vacuum pumps, jet pumps and various water meters, including those of the disk, piston and Venturi types.

On the upper floor of the laboratory, a lecture room 32 × 48 ft. will be equipped during the coming summer. This room will be provided with apparatus by means of which many simple forms of experiments can be performed before the class in theoretical hydraulics, thus establishing by means of actual and visible results the principles which can be emphasized and impressed on the mind of the student only in this way. It is believed that a radical improvement in the method of teaching theoretical hydraulics can be made by this means, and that the information so conveyed will be of a more thorough, lasting and substantial character.

Special lines of important research work will be investigated by expert experimenters. [In addition to routine and to ordinary research work.—Ed.] One special line of experimentation which has been under way for about a year is in relation to centrifugal pumps. For this purpose a special pump has been designed which is sufficiently flexible to admit of a wide range of change in detail. Six forms of cases have been designed, some of which can also be varied by the addition of various forms of fixed turbine blades. Twenty-four forms of closed impellers, in which the number and shape of the impeller blades vary, have been constructed. All of these are to be increased in number and varied in design as the results of the experimental work may warrant. This experimental pump is operated by a variable speed electric motor, and can be run at a wide range of speed. The motor current is determined by the most accurate forms of laboratory testing instruments, and the motor losses are determined with great care, so that the actual power reaching the pump is known with a considerable degree of accuracy. Provisions have been made for a careful study of pressures and velocities in the cases and passages of the pump, and the discharge is obtained over a carefully calibrated weir.

The object of this series of experiments is the establishment of the laws of flow in machinery of this type and the determination of the features which will result in high efficiencies and permit of the attainment of high heads. A special vertical type of centrifugal pump, intended primarily for deep well work, designed by Mr. John W. Alvord, of Chicago, has been presented to the laboratory by Mr. H. H. Porter, President of the Chicago Clearing & Transfer Co.

HENRY WILLIAMS PARKHURST.

An obituary notice of the late H. W. Parkhurst appeared on page 424 of our last issue. Herewith we present a portrait of Mr. Parkhurst, reproduced from one published two years ago in the "Transactions" of the Western Society of Engineers at the time when Mr. Parkhurst was its President. This is the only recent portrait of Mr. Parkhurst of which we have been able to find trace; and it will be valued, we are sure, by his wide circle of friends in the engineering profession.

It may be noted here that Mr. Parkhurst became a Member of the American Society of Civil Engineers in 1877 and not 1897 as stated, through a typographical error, in our last issue.

NEW CONTRACT FORM, PLANS AND SPECIFICATIONS FOR THE MANHATTAN BRIDGE OVER THE EAST RIVER AT NEW YORK, N. Y.

Less than a year ago bids were invited for the construction and erection of the steel superstructure for the Manhattan bridge* over the East River at New York City. The bridge was to be a suspension bridge 2,920 ft. long between faces of anchorages, with a central span of 1,470 ft. between centers of towers; the main carrying element comprised four 20¾-in. steel parallel-wire cables. An unprecedented feature in the design was the use of nickel steel for the main members of the stiffening trusses. The engineers of the Department of Bridges of New York City felt safer, however, in not deciding irrevocably on this material, and they consequently specified an alternative material for the members in question, namely, high-carbon steel, which also had never previously been used in large bridge construction. The manner in which this optional specification was made did not state clearly who was to decide, ultimately, whether nickel steel or high-carbon steel was to be used, so that the bidder necessarily had to figure on the more costly construction. This feature of the plans and specifications, together with certain clauses which would have admitted unlimited amounts of "extras," led to a successful suit for injunction to prevent award of the contract, and the injunction granted was latter upheld by the Court of Appeals of the State of New York which clearly stated that the proposed contract was

*See Engineering News of Aug. 3, 1905, p. 111, for a fully-illustrated description, with extracts from the specifications.

illegal and void.* Consequently a new set of specifications, plans and contract form were prepared by the Department, and new bids have just been invited on these as a basis. The principal differences between the new (1906) and the old (1905) contract are stated in the following. (See p. 46 of the advertising pages of this issue.)

PLANS.

The general and detail plans for the superstructure (towers, cables, stiffening trusses and bracing, and floor system) are identical in substance with those of 1905. A slight change was made in the detail of the tower base castings. Each of these bases, approximately 22 ft. × 42 ft. × 5 ft. 6. ins. high, is made of seven castings bolted together and mounted on a bearing-plate of 1-in. steel. According to the 1905 plans this bearing plate was riveted to the base castings, and a $^1/_{16}$-in. sheet of lead was to be placed between masonry and bearing-plate. The 1906 plans omit the sheet of lead and provide no rivets or other connection between base castings and bearing-plate.

SPECIFICATIONS.

The strictures of the New York State Supreme Court and the Court of Appeals appear to have been very carefully heeded in the preparation of the new specifications and contract form. The principal point of weakness of the old specifications was the option of using either of two totally different materials for an important part of the work, and, in the contract, the ultra-liberal or at least very vague provision for additional or changed work and payment therefor. Both these defects have been remedied, so that no doubt is now left as to the meaning and scope of the undertaking in these points. The opportunity was also taken to make numerous other changes in the specifications, some of which are quite important.

The alternative specification of nickel steel or high-carbon steel for the main members of the stiffening trusses is omitted, and the new specifications call definitely for nickel steel in these members. At the same time the rivets of the chord splices and of the connections of the diagonal web-members are now required to be of nickel steel; under the old specification these rivets were to be of nickel steel or of (medium) carbon steel, the latter being of increased number as demanded by the relative unit-stresses specified for the two materials elsewhere in the specification. Thus, the bridge under the new specifications contains no high-carbon steel whatever.

For all steel, except the cable wire, the new specifications call simply for open-hearth steel against acid open-hearth in the old. Several detail requirements as to raw material and process of manufacture are omitted. Where the old specifications gave but one list of chemical requirements, the new gives parallel lists for acid and basic steel, that for basic steel being the same as the old (acid) list (P 0.04%, S 0.04%, Mn 0.60%, Si 0.10%) while the acid list allows higher phosphorus, 0.06%. Rivet steel is limited to 0.035% P, and 0.03% S. For steel castings only one list is given, P 0.05%, S 0.05%, Mn 0.80%, Si 0.35%. The minimum nickel percentage in the nickel steel, 3.25%, is not changed, nor are the strength requirements (except of course that those for high-carbon steel are omitted). They are given in the table below.

The steel for wire in cables, suspenders and hand-ropes is, however, required as before to be "made in an open-hearth furnace lined with silica." The chemical requirements for this steel are retained, but Sulphur is slightly reduced. The following maximum percentages are specified: C 0.85%, Mn 0.55%, Si 0.20%, P 0.04%, S 0.035%, Cu 0.02%.

The ladle tests for chemical requirements may under the specifications be checked by analyses from the billets; these check analyses may be 25% higher than above specified for phosphorus and 50% higher in sulphur. The old specifications allowed this same variation in the check tests from wire billets, and double this variation in the case of other steel, which allowance has now been unified to the lower figures for all steel.

The working stresses by which the various parts of the structure were designed are the same as in the 1905 specifications (see table at top of p. 113, Engineering News, Aug. 3, 1905), except for the omission of high-carbon steel. The rigid reaming and drilling clauses, the clause against overheating of rivets, and the clause requiring rivets to be heated hotter at the head than at the point, are also retained unchanged.

A clause in the old specification which minutely controlled the procedure of annealing eyebars is omitted, and the 1906 specification merely requires that "annealing of eyebars must be done in accordance with the best modern practice so as to insure uniform results."

PROPOSALS AND CONTRACT.

The 1906 contract form omits all provisions for extra or additional work. The clauses E E and H H of the old contract, quoted in our issue of Nov. 30, 1905, p. 581, are wholly omitted, as is also an accessory clause (D D); clause H, providing for corrections of errors or omissions "when necessary for the proper completion of the work herein stipulated and for the proper fulfilment of the intention" of plans and specifications, is modified by omitting all mention of increased cost or payment therefor. The contract is therefore without the slightest mention of extra work, except as small "extras" may be permitted by the old clause G G, which is retained as clause D D:

> This contract, . . specifications . . and plans . . may be modified and changed from time to time as may previously be agreed to in writing between the parties hereto, in a manner not *materially* increasing the price to be paid, in order to carry out and complete more fully and perfectly the work herein agreed to be done and performed.

We have italicized the word which may allow extra payments under the charter provision that a piece of work costing less than $1,000 may be let without being advertised.

Another interesting change is the reduction of the liquidated damages for non-completion of the work within the specified time, from $500 per day to $250 per day. Corresponding to the damages clause, the 1905 contract contained a bonus clause, which gave the contractor $500 per day for completion before the specified time, up to a total sum of $50,000. This clause has been wholly omitted. Such bonus payment would evidently not be part of the authorized expenditure, nor would it come under the charter provision for letting work costing less than $1,000; the omission of the clause therefore tends to remove a point of legal attack.

The contractor is not wholly disadvantaged by the changes in the 1906 contract, however. The clauses for partial payments as the work progresses have been modified (1) by raising the estimated value of material delivered on the bridge-site ready for erection, from 70% to 75% of that value, and (2) by directing the payment of 90% of the monthly estimates, in place of 85%. More important perhaps, than either of these changes is the addition of a "strike" clause in that paragraph which defines the kind of delay for which extension of time will be made. The added sentence reads as follows:

> If the performance or progress of the work be delayed by reason of labor strikes not caused or instituted or invoked by the contractor, or any sub-contractor . . in the performance or completion of the work hereinbefore described, or by any agent or representative of the contractor, which fact the contractor shall prove to the satisfaction of the commissioner, then the commissioner may in his discretion extend the time for the ultimate completion of the work or any part thereof for such period as the estimation of the commissioner the work shall have been delayed by the said strike or strikes.

But this provision is again governed by a following sentence which specifies that neither an extension of time for any reason nor the acceptance of material shall be deemed a waiver by the Commissioner of the right to abrogate the contract for abandonment or delay, as elsewhere provided in the contract.

Two changes in the Proposals for Bids deserve notice. (1) The present form includes a table of Approximate Quantities, for assistance to the bidder in making his estimate; the 1905 form contained no statement of any of the quantities entering into the work. (2) A clause in the 1905 form restricted the bidding to "such parties as have the requisite plant and facilities," and who are, in the opinion of the Commissioner, "fully qualified both by experience and in appliances" to do the work properly. This clause is wholly absent from the 1906 proposals.

The work of constructing the Manhattan Bridge is to be completed within 3½ yrs. from the time the contractor is notified by the Commissioner to begin work. (The 1905 contract fixed Jan. 1, 1909, as the date of completion.) The bids are to be opened April 30, 1906. Mr. James W. Stevenson is Commissioner of Bridges, and Mr. C. M. Ingersoll, Jr., is Chief Engineer of the Department.

*The primary decision and the disputed specification clauses were printed in full in Engineering News of Nov. 30, 1905, p. 580 (see also editorial comments on p. 577); the essential parts of the decision on appeal were printed in our issue of Feb. 1, 1906, p. 120 (see also p. 128).

STRENGTH REQUIREMENTS OF STEEL FOR MANHATTAN BRIDGE.

	Net Strength, Lbs. Per Sq. Inch.	Min. Elastic Limit* Lbs. Per Sq. Inch.	Min. Reduction of Area, Per Cent.	Min. Elongation. Per Cent.
Medium-carbon Steel.				
Shapes and plates	60,000 — 68,000	33,000	44	1,600,000 / Ult. strength. in 8 ins.
Eyebars, pins and rollers	64,000 — 72,000	35,000	40	
Rivet Rods	50,000 — 58,000	30,000	50	
Eyebars, full-size tests	56,000	30,000	....	15% in 10 ft.
Nickel Steel.				
Shapes and Plates	85,000 — 95,000	55,000	40	1,600,000 / Ult. strength. in 8 ins.
Rivet Steel	70,000 — 80,000	45,000	....	
Steel Castings.				
Test-pieces from coupons on annealed castings	65,000	35,000	....	20% in 2 ins.
Wire for Cables, Hand-ropes and Suspenders.				
Before galvanizing	215,000	....	....	2% in 12 ins.
After galvanizing	200,000	....	....	4% in 12 ins.

*"Elastic Limit" is defined in the specification as "the least stress producing a visible permanent elongation in the gaged length of the specimen as shown by scribe marks of finely-pointed dividers, of a form approved by the Engineer."

MUNICIPAL OWNERSHIP OF WATER-WORKS in Massachusetts has progressed so far that at the close of 1904 a total population of only 211,467 were supplied by 51 private companies as compared with 2,378,570 population supplied by the 129 cities and towns owning their works. The foregoing figures are from the report of the Massachusetts State Board of Health for 1904, and the populations are based on the United States Census of 1900. The report named states that since Jan. 1, 1905 (actual date not given), six towns have either bought or voted to buy the works of the private companies supplying them. These towns had a combined population of 45,430 by the census of 1900. At the time the report was written, all the cities in the state owned their water-works and all but three of the towns of 8,000 population and upwards either owned them or had (two instances) voted to acquire them.

AN EFFICIENCY TEST OF A HIGH-HEAD PELTON wheel was made recently at Bishop, Cal., to determine whether two water-wheels built by the Pelton Water-Wheel Co., of San Francisco, Cal., for the Nevada Power, Mining & Milling Co., of Bishop, came up to contract requirements. The wheels operate under a static head of 1,065 ft. and run at a speed of 450 r. p. m. Each is direct-connected to a 750-KW. alternator which generates current for transmission to the Goldfield and Tonopah districts of Nevada. The wheels were sold under guarantee to develop 80% efficiency, and in order to determine their performance one of the wheels was tested by the purchaser's engineers. The load was measured electrically, the output being carried by a water rheostat and the power measured by integrating wattmeters checked by voltmeter and ammeter readings. The test run under constant load extended over 1½ hrs. In a separate test the electric, friction and windage losses of the generator were determined by running the generator as motor. For the hydraulic measurement, the water consumption was measured by a weir in the tailrace. The head on the wheel was measured by a gage attached to the pipe just back of the gate; allowance was made for the velocity-head, which, however, was small at the point used for measuring the pressure. The test showed an efficiency of 82.8% between nozzle and generator-shaft.

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The conviction and sentence of Gaynor and Greene, for conspiracy with former Captain O. M. Carter to defraud the Government in their contracts for river and harbor work in the Savannah district, marks the termination of the most notable criminal prosecution, doubtless, in the annals of the United States Government. It is nine years since the fraudulent work in Savannah was exposed by Major Cassius E. Gillette on being transferred to the Savannah office, which Carter on one plea or another had retained for a long term of years. Carter's acts were first inquired into by a Board of Officers of his own corps. The accused officer was given every opportunity to clear himself, witnesses were examined and a most thorough investigation was made. The state of affairs uncovered was such as to compel the formulation of charges against Carter and his trial by court martial.

In that trial, which took place just prior to the Spanish war, Carter was found guilty and sentenced to degradation and dismissal and several years imprisonment. A vast amount of influence was exerted to have the court martial's verdict set aside, and not a few men high in public life were engaged to aid Carter and his associates; but all the technicalities and obstructions resulted only in delay and in the end Carter had to serve out his sentence in Leavenworth prison.

Following the conviction of Carter, the Government set about the prosecution of Gaynor and Greene, his co-conspirators; and the delays which were brought about in this case by the shrewd lawyers engaged by the defence became a national scandal. After years of repeated delays, when the net at last tightened around the criminals, they forfeited their bail and fled to Canada. Here they remained for another term of years, taking advantage of every loop-hole in the extradition law; but a final appeal to the English courts swept away subterfuges, and compelled the return of the culprits to the United States for trial.

It was without doubt the hope and expectation of Gaynor and Greene that the long years of delay would result in the death of important witnesses and make conviction impossible; but while there were not a few gaps in the ranks of those who testified against Carter in 1898, ample evidence was brought forward in the 13 weeks of the trial to convince the jury of the prisoners' guilt.

The law's delay in the cases of Carter and his co-conspirators, as has been pointed out in these columns, has resulted in calling wide public attention to the need of revision in the Federal construction have still to undergo much revision, correction and development before they will be safe and satisfactory. In the meantime it will be beneficial to keep a watchful eye on these regulations, and bring them into the forum of public discussion and criticism. Structural engineers throughout the country can thus assist in bringing about a more rapid evolution of governmental control of concrete construction.

Building law regulations dealing with concrete criminal statutes, so that measures framed for the protection of the citizen's liberty, shall not be made use of to shield the criminal and obstruct the administration of justice.

We believe the final results of this remarkable criminal case should be exceedingly gratifying to all good citizens. Even though the wheels of justice have moved so slowly, there is something impressive in the steady persistence with which year after year the Governmental officials have pursued the criminals through every turning and winding of the law, to their refuge in a foreign country, until finally they were brought before a jury for the determination of their guilt and their final punishment.

The strength of a beam is a function of the maximum stress set up in it by a given load. The deflection of the beam is also a function of the stress. But except through their common relation to stress, there is no interdependence of strength and deflection. Two beams of equal span may be equally strong and at the same time one may deflect much more under its load than the other. The amount of deflection, within limits, is unobjectionable from the viewpoint of safety; on the other hand it may be in conflict with considerations of aesthetics or of convenience. For this reason specifications for steel floor framing commonly contain a clause requiring that the framing shall be so designed as to limit the full-load deflection to a specified fraction of the span, usually $^1/_{360}$ or $^1/_{400}$. The engineer or architect, in writing this clause, desires to prevent a construction which may result in short life of plastered ceilings or which may produce a ceiling having the appearance of bulging under load. He has in mind other considerations than those of strength; the latter is adequately cared for elsewhere in the specification.

It is curious to find the same deflection-clause in a public building law. The purposes of the law are to secure structural strength, fire protection, sanitary arrangement, etc., etc. The deflection of floor-beams has no relation to any of these purposes; nothing is gained in structural safety, in fire protection or in sanitation, by limiting the deflection of floor-beams. Yet the clause is permitted to go into the ordinance, cumber the statute-books and complicate the administration of the law. The fact is that here we have an illustration of the essential dissimilarity between building laws and technical building specifications, and an illustration at the same time of the frequent (or even prevalent) confusion of thought which expects to see in a building ordinance a complete specification for proper construction.

It is interesting to read the complaint of one of our readers, in a letter printed on another page, that in at least one city the authorities responsible for the building laws have even gone beyond this error and have specified a limiting deflection for concrete floors.

Doubtless this clause was induced by the similar clause for steel floor work. The compiler of the ordinance reasoned: "If it is proper to call for a certain maximum deflection in steel floor beams and girders, it must be even more so for reinforced concrete; but as the latter is generally a stiffer type of construction, it should be limited to a smaller deflection," for which reason he guessed the fraction one-sixhundredth in place of the one-fourhundredth used for steel. Definite knowledge of the requirements for public safety does not seem to have been concerned in the formulation of this clause.

The concrete and reinforced concrete sections of building laws are not much developed as yet. Where they exist they are either harmful or simply inefficient. As an instance we may cite the 1905 building ordinance of Denver, Colo., whose "general clauses" were editorially criticized by us in our issue of Jan. 11, 1906, pp. 42, 43. The concrete, reinforced concrete and concrete block regulations in this ordinance are not only often obscure and contradictory, but in many points are seriously in disagreement with good practice.

An item has been sent out to the press by the publicity department of the Atchison, Topeka & Santa Fe relating to the Grand Canyon of the Colorado. We quote it in full as follows:

> It is proposed to stretch a heavy cable across the granite gorge of the Colorado River, from bank to bank, and attach to same a movable steel cage, in which passengers will be transported. The distance from rim to rim in mid air, as the crow flies, is thirteen miles. The distance going down the south wall, crossing the river on the cable and ascending the north wall, is fully twenty miles.

Those of our readers familiar with the mathematics of the catenary curve may be interested to compute the total vertical drop of a cable with a length of 20 miles and its points of support 13 miles apart. Those who are not can easily see by a roughly approximate computation that the lowest point of such a cable would be several miles lower than the Colorado River at the bottom of the gorge. It may be added that as a cable of such a span, even if made of high-grade steel wire, would barely support its own weight, no passengers are likely to take the dizzy ride for some time to come.

THE PROBABLE TONNAGE OF THE PANAMA CANAL.

In the design of any transportation route, be it road, railway or canal, one of the important questions to be settled at the outset is what volume of traffic is to be carried.

In the great problem now engaging the attention of the engineering profession, at the Panama Isthmus, there has been of late some very extravagant talk regarding the probable amount of traffic likely to seek the canal when it shall be completed. It has been seriously alleged, for instance, before the Senate Committee, that the sea-level plan of construction ought to be preferred to the lock plan because the sea-level canal has a greater traffic capacity. It has also been brought forward as an argument for the sea-level canal that the Suez Canal last year earned $17,000,000 in interest and dividends for its owners. This indicates, according to the majority report of the Board of Consulting Engineers, that the $333,000,000 estimated as the cost of a sea-level canal, would be a safe investment from a business standpoint. The same argument in slightly different form was brought forward recently by Mr. John F. Wallace before the Senate Committee. Mr. Wallace said:

> Judged by the capitalization and dividends now paid upon the stock of the Suez Canal it is apparent that the rates charged for transit through it are excessive, and on the assumption that the rates for passing through the Panama Canal will be considerably less, a very material saving will be offered to commerce if it takes the Panama route. Assuming that the present amount of tonnage through the Suez Canal of, say, ten million tons per annum would pass through the Panama Canal, even at a dollar a ton, there would be an approximate income of $10,000,000, which is sufficient to justify an expenditure of $300,000,000. As the commerce passing through it, will in the near future pay the interest upon the bonds issued to construct it, without taking into consideration any indirect commercial benefits which would accrue to this country, and without considering the advantages which would be derived from the canal in the improbable event of war, it would seem that an expenditure of $300,000,000, a sum ample to construct the sea-level canal, would be abundantly justified considering the probable rapid development of foreign and domestic trade and the indirect results to be derived from this great waterway. Under these conditions the increased expense of constructing a sea-level canal ought not to weigh very heavily in deciding the question of type.

We must confess that this sort of argument does not appeal to us as sound. If two machines are each capable of performing a certain fixed task, but one will cost twice as much as another, the man who foots the bills will hardly instal the more expensive machine, even though he is assured that the profit on the machine's output will pay 3% interest on its cost. He had rather instal the cheaper machine and earn 6%.

We may add in passing that no estimate of the volume of traffic by the Panama route can be accepted which is based on the idea that ships

will go there because of toll rates lower than those via Suez. Many a glittering prospectus has been framed of the profits a new railway could make by charging rates a little below those of an established rival. Experience has always demonstrated, however, that two can play at the game of rate cutting. If the Suez Canal directors find business diverted to Panama by lower tolls they will be pretty certain to reduce their tolls, also. In the long run, therefore, it is safe to say that geography and sailing distances and not respective rates of toll will determine the proportions of traffic which the two interoceanic canals will carry.

In all the thousands of pages of testimony before the Senate committee during the past three months we have looked in vain for any reference to the estimates of the Panama Canal's future traffic. It appears to have been overlooked for the moment that such estimates have been made, and made under circumstances and conditions which entitle them to respect and attention.

We are aware that it is common to cast doubt on estimates made of the future. Even engineers are sometimes heard to express contempt for such estimates; but it requires only a little thought to see than practically all engineering worthy of the name must forecast and provide for future necessities. The engineer of a water-supply or sewerage system who does not carefully estimate the population likely to call for accommodation for a long term of years to come, will suffer in reputation some day for his lack of foresight. The engineer of a railway who makes no provision for future traffic development, in yards, terminals, motive power, double trackage and signals, will be apt to find himself laid on the shelf as a back number.

Notwithstanding the fact that the Panama Canal is yet to be built, the amount of traffic which will seek it can be estimated probably with quite as much accuracy as the future population of a city. The movement of international trade is so accurately covered by published statistics that it can easily be determined what volume of ocean-going tonnage would at the present time be benefited by a Panama Canal; and past statistics of the growth of ocean traffic enable us to predict something of what future growth may be expected.

As we said above, the future traffic of the Panama Canal was carefully estimated by the Isthmian Canal Commission of 1901, the investigation being under the special charge of Prof. Emory R. Johnson, of the University of Pennsylvania, the well-known economist and statistician. As of especial interest at this time, we print here the following from the official report of that Commission:

A detailed study of the foreign commerce of the United States for the year ending June 30, 1899, and of the commerce of Europe with the western part of the American continents during the calendar year 1899, has been made to ascertain the tons of cargo or freight and the net-register tonnage of the vessels that might have passed through an isthmian canal had one been in existence. The cargo tonnage was found to amount to 6,702,541. This total does not include the comparatively small amount of freight that passed by water between our two seaboards, the statistics of which are not obtainable. It comprises 277,640 tons for the commerce between the Eastern seaboard of the United States and western South and Central America, Hawaii and British Columbia; 1,528,800 tons for the commerce of our Eastern seaboard with Australasia, Oceania, Japan, China and Siberia; 1,629,387 tons for the trade between the West coast of the United States and Europe, and 3,266,654 tons for the commerce between Europe and western South and Central America, western Mexico, Hawaii and British Columbia. It does not include any of Europe's trade with other parts of the Pacific.

The tonnage of the vessels that might have used an isthmian canal in 1899 was ascertained by an examination of the statistics of entrances and clearances kept by the United States and European countries. The entrances and clearances for the commerce of the Eastern seaboard of the United States with Pacific America and with Australia, Oceania, the Philippines, Japan, China and Siberia, and the vessel movements between the western coasts of the American continents and the North Atlantic American and European ports, were found to amount to 4,074,852 vessel-tons net register, including 336,998 tons for the commerce now crossing the Isthmus of Panama.

This total was compared with the results of a traffic investigation made by the New Panama Canal Company. The records of vessel movements kept by that company show a traffic for the calendar year 1899 of 3,848,577 tons net register for the commerce between Europe and the western coast of the American continent, between the Atlantic seaboard of America and trans-Pacific countries, and between the two American seaboards. The total obtained from the records kept by the Panama Company does not include any vessel tonnage for the commerce now crossing the Isthmus. The addition of that tonnage, 336,998 tons, raises the total to 4,185,575.

In addition to this tonnage, which comprises only traffic originating or terminating in America, there should be included most of the commerce of northwestern Europe with New Zealand and the other islands of the Pacific east of Australia. New Zealand will be 1,503 miles nearer Liverpool by the isthmian canal than via the Suez route, and 2,405 miles nearer than by way of the Cape of Good Hope. The distances to Liverpool from the important groups of South Pacific islands north of New Zealand will be from 500 to 5,500 miles less via the isthmian canal than by way of Suez. The entrances and clearances of New Zealand's trade with northwestern Europe amounted to 481,178 tons net register in 1899, and the European commerce of the other islands east of Australia to 181,743 tons. Of this total traffic of 662,921 tons, 500,000 might have advantageously used an isthmian canal, and this amount should be added to the canal tonnage originating or terminating in America. This makes the total obtained by the Commission's investigation of the tonnage that might have used an isthmian canal in 1899, 4,574,852 tons net register; and the total obtained by adopting the New Panama Canal Company's figures for the traffic originating or terminating in America, 4,685,575 tons.

The closeness of the results obtained by two independent investigations should be certainly conclusive as to the reliability of these estimates. The Commission in its official report, then proceeded to investigate the probable rate of future growth of the canal traffic. The best guide to the rate of growth, undoubtedly, is the rate of growth of the Suez Canal traffic. The figures in the accompanying table are taken from the Commission's report:

NO. OF VESSELS AND TOTAL TONNAGE PASSING THROUGH THE SUEZ CANAL FOR 5-YEAR PERIODS.

Years.	No. of Vessels.	Net Tonnage Danube Measurement.	Actual Increase of Tonnage, over Preceding Period.	Actual Increase over Average Annual Rate.	Average No. Vessels, Per Annum.	Average Tonnage Per Annum.
1870-74	4,770	5,358,237	.....	.....	954	1,071,647
1875-79	7,684	10,995,214	5,636,977	1,125,395	1,537	2,199,043
1880-84	14,542	23,916,373	12,921,159	2,584,232	2,908	4,783,274
1885-89	16,726	31,430,454	7,514,081	1,502,816	3,345	6,286,091
1890-94	17,848	39,899,143	8,458,689	1,691,738	3,569	7,979,828
1895-99	16,939	44,042,274	5,143,131	1,028,626	3,388	8,808,455

From their study of this table and from other statistics of the growth of ocean traffic, the Commission of 1901 concluded that a rate of traffic growth of 25% per decade was a conservative estimate of the rate of growth of commerce, and that assuming that the canal might be completed and opened in 1914, the volume of traffic then awaiting it would be 6,401,332 tons in 1914. For the growth afterwards the Commission concluded, using the geometrical increase method of calculation, that by 1924, the end of the first decade, this would be increased to 10,500,000 tons. To us, the arithmetical increase seems the more accurate method of calculation. An inspection of the above table would seem to indicate that the increase in annual tonnage through the Suez Canal has averaged about 1,500,000 tons in five years, or 3,000,000 tons per decade. Thus the Suez Canal, opened with less than a million tons traffic in 1870, increased to 9,738,152 tons in 1900.

If the Panama Canal can increase its traffic at the same arithmetical rate as the Suez Canal has done and carries at its opening in, let us say, 1915, 6,500,000 tons when opened, it will carry 9,500,000 tons in 1925, and at later periods as follows:

Year.	Annual traffic, tons.
1935	12,500,000
1945	15,500,000
1955	18,500,000
1965	21,500,000

A continuation of this rate of increase would give it a traffic of 32,000,000 tons at the end of the century.

It may be said with truth that the radical and far-reaching changes which may result from the world's progress in science and invention and civilization make uncertain any estimate of volume of traffic for a period half a century or more distant; but it is also true that these unknown changes make it unwise to try to construct engineering works to provide for the needs of so remote a period which may be entirely different from what can to-day be foreseen. The exhaustion of the world's existing stock of raw materials is bound to make enormous changes in traffic conditions. For illustration the beds of Chilian nitrate which have for many years past furnished a vast amount of tonnage to vessels passing around the Horn. It is said these deposits will be practically exhausted in a few years; probably very little will be left by the time the Panama Canal is completed.

We must not overlook also, the central tendency of manufacturing. A great part of international commerce in the past and at present consists in the transport of raw materials from the comparatively undeveloped countries of the world to the manufacturing nations of Europe and America. This is not a permanent condition. India and Australia and China are ambitious to supply their own needs and work up their own raw materials. With the advancing spread of civilization, the factory system will extend to the remote parts of the world. Of course international commerce will continue, and will be of vast proportions; but we merely call attention to the fact that certain tendencies of civilization operate to reduce as well as to increase the volume of international trade.

Doubtless those who are inclined to view the future through a magnifying glass will cite the phenomenal growth of traffic through the Sault canals as an argument for a more rapid growth of traffic at Panama than that estimated above. It is true that the net registered tonnage of the St. Mary's River has had the astounding increase from 700,000 tons in 1870 to 36,600,000 tons in 1905. The great bulk of this increase, however, is due to the discovery of the vast iron ore deposits to the north of Lake Superior coupled with the fact that no coal suitable for the reduction of this ore was locally available. It is the iron ore traffic which is responsible for the marvellous fleets passing up and down the St. Mary's River, as may be seen by the statement that of the 44,270,680 tons of freight recorded as passing the Sault last year, 31,332,637 tons were iron ore. Thus were it not for the ore movement, the traffic growth of the Sault route in 35 years would be less than the growth recorded at Suez.

Undoubtedly, since what we wish to estimate is international trade, ocean borne, the experience at Suez forms the best of all guides in forecasting the volume of traffic to be provided for at Panama. In our estimate above we have assumed that the rate of increase will be as great at Panama as it has been at Suez; but there are good reasons for believing that Panama will not only begin with a traffic much below that of Suez but that it will increase at a slower rate. Study of maps of the world or a globe will make this clear. The Suez route is the only highway between Europe and Asia, with its teeming millions of population, and the rapidly developing west coast of Africa. These are all one vast continental mass, and the exchange of the raw materials of Asia and Africa for the manufactures of Europe represents a commerce of large volume and capable of great expansion. In comparison with the vast population in the countries bordering the Indian Ocean, the Panama route gives access to the west coast of South America, a narrow strip of territory, rich in mineral wealth it is true, but sparsely peopled. The west coast of North America offers far more in probable volume of trade; but it is rapidly supplying its own needs in manufactures and using up its own wheat and other productions to supply

its own population instead of sending it to Europe. There is also the Australian trade, but much of that will go by Suez instead of Panama, and the population there is likewise fast tending to become self-supporting and relying less on imports.

We set forth these facts for the benefit of those who may think the figures above given for the future traffic at Panama too small. We are not unaware that some special sources of traffic exist at Panama such as that between California, Oregon and Washington and the Atlantic coast states, or the shipment of lumber from the forests of Washington and British Columbia to the eastern United States and to Europe; but it is precisely such sources of traffic as these that must be counted on if Panama is to have in the next sixty years a rate of arithmetical increase equal to what Suez had in the last three decades of the century.

It may be of interest, now, to see just what the traffic estimates of tonnage above set forth represent in number of vessels; for there appears to be a popular idea that the Panama Canal when opened is to have a continuous procession of ships passing through it, like electric cars on a city street. For our guide here we may turn again to the Suez Canal. In 1904, with a net tonnage movement of 13,401,835 tons, Danube measurement, equivalent to about 11,500,000 tons net register, there were 4,237 vessels passed through the Suez Canal, or an average of less than 12 vessels per day, or one vessel every four hours in each direction. The average size of these vessels was about 2,700 tons, which would permit two or even three vessels at a time to be passed through locks of the size proposed at Panama.

We have quoted above official estimates of 6,500,000 tons as the Panama Canal traffic in 1915 and 10,500,000 tons in 1924. If the average size of vessels at Panama is equal to that at Suez, we may suppose that by 1924, eighteen years hence, this average size will have increased to 3,300 tons, and this would give an annual traffic of 3,080 vessels, or 1,540 in each direction, or 4⅙ daily in each direction. As many of the lockages would be made with two or more vessels at one time, when vessels come along close together, and as the duplicate locks would provide different locks for vessels moving in each direction, it appears that with the traffic to be expected at Panama after the canal has been opened ten years, each lock will be used to pass vessels on the average about three times in each 24 hours.

We suggest that this picture of actual conditions as they will exist in the canal when completed deserves the serious attention of those who desire to form a correct opinion as to the proper type of canal to build at Panama. From much of the testimony of the sea-level advocates, one might easily conclude that a continuous procession of ships, only a few minutes apart, was likely to seek passage through the canal as soon as it is opened, and that the passage through a lock would obstruct the movement of this fleet. The actual conditions to be met as shown by the above careful estimates are the farthest possible from this. If a lock can be called an "obstruction to traffic" under such conditions, then the enclosed docks of Liverpool and London and other great seaports of the world are obstructions to traffic.

We imagine, however, some one objects that with the steady growth of traffic year by year, there will come a time, perhaps fifty years hence, perhaps a hundred years hence, or perhaps at an even more remote date, when the traffic will reach such a volume that a sea-level canal will be called for. If we admit this supposition we must also admit that it is not good business nor sound economic policy to make provision now for necessities that will probably not be felt for at least a century to come. By the time a sea-level canal is needed at Panama it is quite within the probabilities that methods and appliances for excavation under water may have been so revolutionized that it would cost less then to make a sea-level channel all the way across than it would cost now to excavate it in the dry.

LETTERS TO THE EDITOR

Projecting a Tangent from a Curve Through a Given Point.

Sir: Mr. D. D. Stiltz in the News of March 15, 1906, states that the solution of the problem of projecting a tangent from a curve through a fixed point as presented by him is new, at least to him, but on page 133 of J. B. Henck's "Field-Book for Railroad Engineers" can be found the same old problem and the same old equations in the same old letters, printed some 20 years ago.

Yours very truly, O. W. Jasper.

Oroville, Butte Co., Cal., March 21, 1906.

Foundations for Reinforced Concrete Arch Bridges.

Sir: In your issue of April 5, over the signature of Mr. Carl Gaylor, C. E., there appears a timely criticism of the careless design shown in many highway bridge abutments and piers, with especial reference to the Charley Creek bridge described in the preceding issue of March 15. He bases his entire criticism of this structure, however, upon an erroneous assumption, i. e., that the abutments and pier are not founded upon rock. The abutments and pier of this bridge were especially designed with reference to the fact that the bed-rock was very close to the surface and the drawings clearly call for them being carried to a rock foundation, as was done, although this is not clearly brought out in the illustration.

Very truly yours,

F. F. Weld,

Chief Draftsman, Trussed Concrete Steel Co.

Detroit, Mich., April 7, 1906.

Measuring Long Distances with a Transit.

Sir: I have noticed several articles in your journal recently concerning the measurement of distances with stadia, but have never seen anything concerning a method of field work used in this section that accomplishes the same result of measuring distances without the use of chain or tape.

It is a method used principally in drainage area surveys, but can be used in any work not requiring great accuracy, and is, I think, as accurate as any of the forms of stadia.

In drainage area work our courses are taken by needle bearing, and the distances are measured as follows: The transitman sets up on one point on the ridge while a flagman holds a transit rod on another point. The transitman takes the bearing of the line by needle, then with his verniers set at zero he lines as closely as possible on the transit rod. The flagman then marks this point with a marking pin and the transitman then turns an angle of 34′ 30″ either way and lines in the flagman closely, the flagman taking his line at right angles to the ridge line. The distance between these two points is then measured to the nearest hundredth, and as the angle 34′ 30″ gives an offset or chord of 1 ft. for every 100 ft., this will give the distance along the ridge to the nearest foot. This, it seems to me, is as accurate as using a level rod and stadia wires, and the only limit to the distance is the ability of your flagman to take signals, and the power of the transit telescope. I have taken sights in this way 7,200 ft. in a clear atmosphere. By this method there is no calculation necessary for reduction of measurements to horizontal. I have been using this method for years and find the field work plots very nicely.

Yours truly, R. A. Rutledge,

Res. Engr., G., C. & S. F. Ry.

Beaumont, Tex., March 29, 1906.

Reinforced Concrete Buildings at Los Angeles, Cal.

Sir: The great extension in the use of reinforced concrete that has taken place during the past ten years, and its adaptation to an increasing variety of uses, is well exemplified in recent types of construction in Los Angeles.

In its use for the entire construction of ordinary buildings (no steel framework being used), one of the latest examples is the 8-story Hayward Hotel building at Sixth and Spring Sts. This is being built (now nearly completed) by Mr. Henderson Hayward for a hotel. The dimensioning throughout was made with a view to the subsequent addition of two more stories.

On the ground floor near the front corner of the building a panel 15 ft. square was tested with a loading of 465 lbs. per sq. ft. (104,625 lbs.), and there was a deflection of only ¼ inch.

For this building Chas. F. Whittlesey is the architect and Carl Leonardt the contractor.

The most notable adaptation, probably in the world, of reinforced concrete to long-span girders for support of a roof is furnished by the warehouse built and owned by Mr. Leonardt at the corner of Mill and Industrial Sts., Los Angeles, which was finished in 1905, and was illustrated in Engineering News, volume Jan.-June, 1905, p. 422.

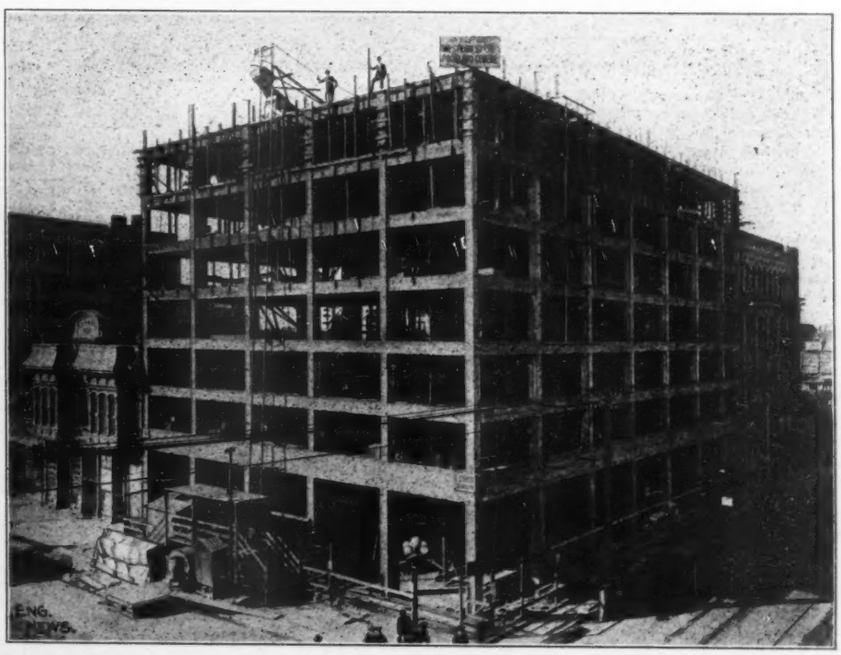
The roof of this warehouse is carried by girders 102 ft. long in the clear and spaced 16 ft. c. to c. The girders are dimensioned to carry the dead load (concrete taken as 145 lbs. per cu. ft.) and a live load of 30 lbs. per sq. ft. Each girder is 14 ins. wide and has a depth varying from 3 ft. at the ends to 6 ft. 10 ins. at the center.

What will be probably the most noteworthy reinforced concrete building yet constructed is the new Auditorium Building, at Fifth and Olive Sts., now under construction. This magnificent structure, the auditorium of which will have a seating capacity of 5,000, will be nine stories high in the office portion, fronting on the streets. The auditorium proper will take the height of only four stories with its four different levels; but the roof overhead will be supported by concrete girders having a clear span of 114 ft. W. P. H.

Los Angeles, March 15, 1906.

An Arbitrary and Inequitable Requirement for Concrete Floor Constructions.

Sir: I desire to call your attention to the following quotation from the building laws of a city of between



THE EIGHT-STORY HEYWARD HOTEL BUILDING, REINFORCED CONCRETE CONSTRUCTION, AT LOS ANGELES, CAL.

200,000 and 300,000; I understand that similar laws are in force in another city of about 400,000. Referring to tests on concrete floors:

Such tests, when made sixty (60) days after the concrete is in place, shall show that the construction will sustain a load of two (2) times that for which it is designed without any sign of failure, and in case of beams, girders or floors, the deflection due to such loading shall not exceed one six-hundredth (1-600) of the span.

Bearing in mind the fact that the deflection of a beam varies with the cube of its depth for any given working stress, when we come to compare the rational deflection of a floor slab of 1-600 of its span, with that of a beam say 20 ins. deep of the same span, the absurdity of this regulation is apparent. The beam might be readily overstrained and cracked with a 1-600 deflection, while the slab might readily be loaded until the deflection is two or three times this amount, without cracking or injuring it. The relative deflection of the two, with a reasonable span of 15 or 18 ft. would be, on the basis of a 6-in. slab and a 20-in. beam, 20 or 25 times as much for a slab as for the beam.

It would seem as though ordinarily intelligent men could frame a more rational ordinance to govern the execution of work in a city of this size, provided that they are familiar with even the elementary principles of engineering. The writer would be pleased to hear from other correspondents as to similar idiotic regulations in force in other places, as it is only by publicity and the exhibition of such absurdities that the public safety can be protected and the interests of those legitimately engaged in the concrete business protected against those interested in other types of construction.

Yours very truly,
Concrete Contractor.

April 7, 1906.

[The clause quoted above seems very much like a modified transfer from specifications for structural steel floor-framing, where deflections have commonly been limited to $^1/_{800}$ or $^1/_{400}$ of the span, to avoid cracking plastered ceilings. As concerns the reasonableness of limiting deflection to a fixed fraction of the span in steel framing, there may be good question, since the distance of the ceiling surface from the neutral axis of the floor beam should enter as a factor. But the rule is almost universally used, is confessedly a purely empirical thing, and is rarely or never a limiting factor in the design of steel framing. In the case of concrete construction, however, there does not seem to be the slightest reason for erecting a requirement of this character; if there is any reason we should be glad to learn of it. The injurious nature of the rule is well enough suggested in the above letter. If enforced, it must operate to seriously hamper the progress and the commercial use of reinforced concrete within its jurisdiction. Further comments on the matter are made in our editorial columns.—Ed.]

Land Surveys in the Indian Territory.

Sir: I was very much interested in the article on "Public Land Survey by Government Engineers in Indian Territory," by Charles H. Fitch, published in your issue of Feb. 8, 1906. I have had occasion to make considerable use of these surveys and also the level lines run and found them excellent. I had hoped, however, that Mr. Fitch would explain one thing about that survey that I never understood.

Some time in the '80s the Gulf, Colorado & Santa Fe Ry. obtained its charter and right-of-way through the Chickasaw Nation, which is included in the survey mentioned by Mr. Fitch, and the alinement was tied to the government surveys then existing. I was in this locality when the government forces were at work on the later survey in 1901, I think, and have since had occasion to tie to the new work in several places. I find the new lines are entirely different from those shown on our original maps. As I recollect it, the lines are moved south and east from 400 to 600 ft., and the old corners have been destroyed. Is this another case of "Benson" mentioned in one of your recent issues, which the government has been compelled to correct?

Yours truly, R. A. Rutledge,
Res. Engr., G., C. & S. F. Ry.

Beaumont, Tex., March 29, 1906.

[Proof of the above letter was sent to Mr. Fitch and his reply follows.—Ed.]

Sir: I take pleasure in replying to the inquiry of Mr. R. A. Rutledge regarding a resurvey of Chickasaw Nation, Indian Territory.

A resurvey of the Chickasaw Nation was a necessity because of the fact that in the lapse of about 25 years most of the original corners had disappeared, and as no land titles were based upon the first survey, a new survey was authorized by an act of Congress. The act referred to stated that "in making the resurvey the former land survey is to be disregarded, the latter now being declared null and void."

If the new survey had reestablished the old corners, an enormous amount of work would have been involved in running and rerunning lines and making adjustments, in order to reproduce as nearly as might be the old survey as it actually existed on the ground. The new survey was made without reference to the old survey, except to destroy the old corners wherever found. As the same initial point was used, there was very little difference in the two lines, until the survey had progressed some distance from the initial point. I do not think that there were glaring errors in the original survey, but it was not as well and permanently marked as it should have been. The government surveyors "tied" the land survey to the railroad wherever crossed.

Yours truly, C. H. Fitch.

Washington, D. C., April 11, 1906.

Some Clerical Errors in the Official Estimate of the Cost of a Sea-Level Canal at Panama.

Sir: In the issue of your journal of Feb. 22 there was published a very full abstract of the report of the Board of Consulting Engineers for the Panama Canal.

Th.s report contains the following:

Estimate of Excavation of a Sea-Level Canal 40 Feet Deep.

Stations.	Classification.	Cu. yds.	Price.	Amount.
41-ft. contour to shore line of Limon Bay, 0 to mile 3.92	Earth	2,781,668	$0.15	$417,250.00
	Indurated clay	5,566	.70	3,896.20
	Coral	135,500	1.50	203,250.00
	Total	2,922,734	....	624,396.20
Shore line to Mindi, mile 3.92 to mile 5.49	Earth	7,695,885	.25	1,923,971.25
	Indurated clay	2,351,588	.70	1,646,111.60
	Total	10,047,473	....	3,570,082.85
Mindi to Bohio, mile 5.49 to mile 17.22	Earth	21,730,653	.25	5,432,663.25
	Rock above sea level.	628,088	1.00	628,088.00
	Rock below sea level.	2,198,643	2.50	5,497,107.50
	Total	24,557,384	....	11,557,858.75
Bohio to Obispo, mile 17.22 to mile 30.96	Earth	48,787,149	.40	19,514,859.60
	Rock above sea level.	4,490,926	1.15	5,164,564.90
	Rock below sea level.	7,396,362	2.50	18,491,905.00
	Total	60,674,437	....	43,171,329.50
Obispo to Pedro Miguel, mile 30.96 to mile 39.04	All mat'rl above + 10.	93,697,408	.80	74,957,926.40
	All mat'rl below + 10.	16,194,302	1.25	20,242,877.50
	Total	109,891,710	....	95,200,803.90
Pedro Miguel to Miraflores, mile 39.04 to mile 40.77	Earth above sea level.	2,136,125	.40	854,450.00
	Earth below sea level.	300,000	.25	75,000.00
	Rock above sea level.	518,881	1.15	596,713.15
	Rock below sea level.	2,474,138	2.50	6,185,345.00
	Total	5,429,144	....	7,711,508.15
Miraflores to south end of Sosa lock, mile 40.77 to mile 45.37	Earth	6,106,828	.40	2,444,731.20
	Rock nearly all below sea level	5,223,700	2.50	12,659,250.00
	Total	11,330,528	....	15,103,981.10
South end Sosa lock to 45-ft. contour in Pacific, mile 45.37 to mile 49.35	Earth	3,508,945	.15	526,341.75
	Rock	2,663,922	2.50	5,659,805.00
	Total	6,172,867	....	6,186,146.75
	Grand total	231,026,477		$183,136,107.30

I beg leave to call attention to a number of clerical errors, which may be noted, and which altogether affect the final result in a very material degree.

The subjoined accounting is the same as the foregoing with the correct computation of the several sums.

EXCAVATION OF CANAL.

Classification.	Cu. yds.	Price.	Amount.
Earth	2,781,668	$0.15	$417,250.00
Indurated clay	5,566	.70	3,896.20
Coral	135,500	1.50	203,250.00
Total	2,922,734		$624,396.20
Earth	7,695,885	.25	1,923,971.25
Indurated clay	2,351,588	.70	1,646,111.60
Total	10,047,473		3,570,082.85
Earth	21,730,653	.25	5,432,663.25
Rock	628,088	1.00	628,088.00
Rock	2,198,643	2.50	5,496,607.50
Total	24,557,384		11,557,358.75
Earth	48,787,149	.40	19,514,859.60
Rock	4 490 926	1.15	5,164,564.90
Rock	7,396,362	2.50	18,490,905.00
Total	60,674,437		43,170,329.50
Material above (10.)	93,697,408	.80	74,957,926.40
Material below (10.)	16,194,302	1.25	20,242,877.50
Total	109,891,710		95,200,803.90
Earth above sea level	2,136,125	.40	854,450.00
Earth below sea level	300,000	.25	75,000.00
Rock above sea level	518,881	1.15	596,713.15
Rock below sea level	2,474,138	2.50	6,185,345.00
Total	5,429,144		7,711,508.15
Earth	3,508,945	.15	526,341.75
Rock	5,223,700	2.50	13,059,250.00
Total	11,330,528		15,501,981.20
Earth	3,508,945	.15	526,341.75
Rock	2,663,922	2.50	6,659,805.00
Total	6,172,867		7,186,146.75
Grand Total	231,026,277		$184,522,607.00

By comparing this calculation with that of the Consulting Board, as printed, it appears that there are seven errors, five in multiplying and two in adding, all of which making a difference in the grand total of $1,386,500.

The complete estimate of cost of the Canal, including excavation, and all constructive and auxili... works is also appended:

Jetties in Limon Bay	...000,000
Excavation and dredging in earth, rock, etc throughout the canal	136,000
Completion of river diversions, formation dams across tributary streams, regulation of rivers which flow into the canal, etc	500,000
Dam across Chagres Valley at Gamboa, with flood sluices, etc.	...000,000
Spillway, with flood sluices, near La Boca	320,000
Twin tidal locks in the Ancon-Sosa saddle	...000,000
Leading jetties above and below locks	785,000
Relaying track of Panama Railroad	500,000
20% for contingencies, administration and engineering	...851,000
	170,200
Total	...021,200
But to this sum total	...851,000
There must be added the amount of deficiency by errors in computation	1,386,500
And 20% for contingencies, administration and engineering	...237,500
	11,447,500
Total	...18,685,000

This, then, is the true estimate of cost for the sea-level canal, and the gross error is a sum amounting to $1,664,200, that being the difference between the total as given and as corrected.

Yours very truly,
Lewis H. Cowles.

581 The Arcade, Cleveland, O., April 10, 1906.

[It had not occurred to us to question the arithmetic of the sea-level canal advocates, although we had doubted the soundness of their engineering.—Ed.]

Positive and Negative Notes on Shop Drawings.

Sir: I have been very much interested in reading "Shop Hints for Structural Draftsmen" by Mr. John C. Moses, and would like to ask the writer a question. In the article entitled The Draftsman and the Bridge-Shop in your issue of March 29, the writer makes this statement: "Notes should be given positively, stating that a 'Bracket goes on Columns 1, 2, 3, 4 and 6,' and not 'Omit bracket on Column 5 only'."

It has been my privilege to work in companies using both the negative and positive systems of noting, and it always seemed to me that the best method was to use a note affecting the least number of pieces. For instance, in my experience as a Shop Inspector, if I found a note like the one cited above, the first thing I did was to make a pencil memorandum on the blue print: "Omit bracket on Column 5." In one case a drawing showing 20 different kinds of roof trusses had a note: "These holes in T 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 and 18 only." On talking with the assemblers it was found that they did precisely what the Inspector did, namely, went through the list and made a note of the two trusses in which these holes were omitted.

Various explanations for the use of the positive system have been made, among which one is that you would not make a drawing of a column and send it to the shop with a note on it "Do not make this column," or, in general, the draftsman should not draw a member and then put an "omit" note on it. The argument may be all right, but it would appear to me to be better to put the note in such a way as to be most easily interpreted by the shop. And it looks reasonable that if we have a drawing showing a bracket on a column, and that bracket is to be put on five of the six columns called

A TABLE FOR THE COMPUTATION OF PAY-ROLLS. By Wm. Wallace Wotherspoon, C. E.

Day of 8 Hours.	Hours.	.125	.156	.187	.20	.219	.25	.28	.312	.344	.375	.40	.406	.438	.469	.563	.094
		1.00	1.25	1.50	1.60	1.75	2.00	2.25	2.50	2.75	3.00	3.20	3.25	3.50	3.75	4.50	.75
	⅛	.03	.08	.09	.10	.11	.13	.14	.16	.17	.19	.20	.20	.22	.23	.28	.05
	1	.13	.16	.19	.20	.22	.25	.28	.31	.34	.34	.40	.41	.44	.47	.56	.09
	1⅛	.19	.23	.28	.30	.33	.38	.42	.47	.52	.51	.60	.61	.65	.70	.84	.14
¼	2	.25	.31	.38	.40	.44	.50	.56	.63	.69	.75	.80	.81	.88	.94	1.13	.19
	⅛	.31	.39	.47	.50	.55	.63	.70	.78	.86	.94	1.00	1.02	1.09	1.17	1.41	.23
	3	.37	.47	.55	.60	.66	.75	.84	.94	1.03	1.13	1.20	1.22	1.31	1.41	1.69	.28
	⅛	.44	.55	.66	.70	.77	.88	.98	1.09	1.20	1.31	1.40	1.42	1.53	1.64	1.97	.33
½	4	.50	.62	.75	.80	.88	1.00	1.13	1.25	1.38	1.50	1.60	1.63	1.75	1.88	2.25	.38
	⅛	.56	.70	.81	.90	.98	1.13	1.23	1.41	1.55	1.69	1.80	1.83	1.97	2.11	2.53	.42
	5	.62	.78	.94	1.00	1.09	1.25	1.41	1.56	1.72	1.88	2.00	2.03	2.19	2.34	2.81	.47
	⅛	.69	.86	1.03	1.10	1.20	1.38	1.55	1.72	1.89	2.06	2.20	2.23	2.41	2.58	3.00	.52
¾	6	.75	.91	1.13	1.20	1.31	1.50	1.69	1.88	2.06	2.25	2.40	2.44	2.63	2.81	3.38	.56
	⅛	.81	1.01	1.21	1.30	1.42	1.63	1.83	2.03	2.23	2.44	2.60	2.64	2.81	3.05	3.66	.61
	7	.87	1.09	1.31	1.40	1.53	1.75	1.97	2.19	2.41	2.63	2.80	2.84	3.03	3.28	3.94	.66
	⅛	.94	1.17	1.41	1.50	1.64	1.88	2.11	2.34	2.58	2.81	3.00	3.05	3.28	3.52	4.22	.70
1 day	8	1.00	1.25	1.50	1.60	1.75	2.00	2.25	2.50	2.75	3.00	3.20	3.25	3.50	3.75	4.50	.75
	⅛	1.06	1.33	1.59	1.70	1.81	2.13	2.39	2.66	2.92	3.19	3.40	3.45	3.72	3.98	4.78	.80
	9	1.13	1.41	1.69	1.80	1.97	2.25	2.53	2.81	3.09	3.38	3.60	3.66	3.94	4.22	5.03	.84
	⅛	1.19	1.48	1.78	1.90	2.03	2.38	2.67	2.97	3.27	3.56	3.80	3.83	4.16	4.45	5.34	.89
1¼	10	1.25	1.56	1.88	2.00	2.19	2.50	2.81	3.13	3.44	3.75	4.00	4.05	4.38	4.69	5.63	.94
	⅛	1.31	1.64	1.97	2.10	2.30	2.63	2.95	3.28	3.61	3.94	4.20	4.27	4.59	4.92	5.91	.98
	11	1.37	1.72	2.03	2.20	2.41	2.75	3.09	3.41	3.78	4.13	4.40	4.47	4.81	5.16	6.19	1.03
1½	⅛	1.44	1.80	2.16	2.30	2.52	2.88	3.23	3.59	3.95	4.31	4.60	4.67	5.03	5.39	6.47	1.08
	12	1.50	1.87	2.25	2.40	2.63	3.00	3.38	3.75	4.13	4.50	4.80	4.88	5.25	5.63	6.75	1.13
	⅛	1.56	1.95	2.34	2.50	2.73	3.13	3.51	3.91	4.30	4.69	5.00	5.08	5.47	5.86	7.03	1.17
	13	1.62	2.03	2.44	2.60	2.84	3.25	3.66	4.06	4.47	4.88	5.20	5.28	5.69	6.09	7.31	1.22
1¾	⅛	1.69	2.11	2.53	2.70	2.95	3.38	3.80	4.22	4.64	5.06	5.40	5.48	5.91	6.33	7.59	1.27
	14	1.75	2.19	2.63	2.80	3.06	3.50	3.94	4.38	4.81	5.25	5.60	5.69	6.13	6.56	7.88	1.31
	⅛	1.81	2.26	2.72	2.90	3.17	3.63	4.08	4.53	4.98	5.44	5.80	5.89	6.34	6.80	8.16	1.36
	15	1.87	2.34	2.81	3.00	3.28	3.75	4.22	4.69	5.16	5.63	6.00	6.09	6.56	7.03	8.44	1.41
2 days	⅛	1.94	2.42	2.91	3.10	3.39	3.88	4.36	4.84	5.33	5.81	6.20	6.30	6.78	7.27	8.72	1.45
	16	2.00	2.50	3.00	3.20	3.50	4.00	4.50	5.00	5.50	6.00	6.40	6.50	7.00	7.50	9.00	1.50
	⅛	2.06	2.58	3.09	3.30	3.61	4.13	4.64	5.16	5.67	6.19	6.60	6.70	7.22	7.73	9.28	1.55
	17	2.13	2.66	3.19	3.40	3.72	4.25	4.78	5.31	5.84	6.38	6.80	6.91	7.44	7.97	9.56	1.59
	⅛	2.19	2.73	3.28	3.50	3.83	4.38	4.92	5.47	6.02	6.56	7.00	7.11	7.66	8.20	9.84	1.64
2¼	18	2.25	2.81	3.38	3.60	3.94	4.50	5.06	5.63	6.19	6.75	7.20	7.31	7.88	8.44	10.13	1.69
	⅛	2.31	2.89	3.47	3.70	4.05	4.63	5.20	5.78	6.36	6.94	7.40	7.52	8.09	8.67	10.41	1.73
	19	2.37	2.97	3.56	3.80	4.16	4.75	5.34	5.94	6.53	7.13	7.60	7.72	8.31	8.91	10.69	1.78
2½	⅛	2.44	3.05	3.66	3.90	4.27	4.88	5.48	6.03	6.73	7.31	7.80	7.92	8.53	9.14	10.97	1.83
	20	2.50	3.13	3.75	4.00	4.38	5.00	5.63	6.25	6.88	7.50	8.00	8.13	8.75	9.38	11.25	1.88
	⅛	2.56	3.20	3.84	4.10	4.48	5.13	5.76	6.41	7.05	7.69	8.20	8.33	8.97	9.61	11.53	1.92
	21	2.62	3.28	3.94	4.20	4.59	5.25	5.91	6.56	7.22	7.88	8.40	8.54	9.19	9.84	11.81	1.97
2¾	⅛	2.69	3.36	4.03	4.30	4.70	5.38	6.04	6.72	7.39	8.06	8.60	8.73	9.41	10.08	12.09	2.02
	22	2.75	3.44	4.13	4.40	4.81	5.50	6.19	6.88	7.56	8.25	8.80	8.94	9.63	10.31	12.38	2.06
	⅛	2.81	3.51	4.22	4.50	4.92	5.63	6.33	7.03	7.73	8.44	9.00	9.14	9.84	10.55	12.66	2.11
	23	2.87	3.59	4.31	4.60	5.03	5.75	6.47	7.19	7.91	8.63	9.20	9.34	10.06	10.78	12.93	2.16
3 days	⅛	2.94	3.67	4.41	4.70	5.14	5.88	6.61	7.34	8.08	8.81	9.40	9.55	10.28	11.02	13.22	2.20
	24	3.00	3.75	4.50	4.80	5.25	6.00	6.75	7.50	8.25	9.00	9.60	9.75	10.50	11.25	13.50	2.25
	⅛	3.06	3.83	4.59	4.90	5.36	6.13	6.89	7.66	8.42	9.19	9.80	9.95	10.72	11.48	13.78	2.30
	25	3.13	3.91	4.69	5.00	5.47	6.25	7.03	7.81	8.59	9.38	10.00	10.16	10.94	11.72	14.03	2.34
	⅛	3.19	3.98	4.78	5.10	5.58	6.38	7.17	7.97	8.77	9.56	10.20	10.36	11.16	11.95	14.34	2.39
3¼	26	3.25	4.06	4.88	5.20	5.69	6.50	7.31	8.13	8.94	9.75	10.40	10.56	11.38	12.19	14.63	2.44
	⅛	3.31	4.14	4.97	5.30	5.80	6.63	7.45	8.28	9.11	9.94	10.60	10.77	11.59	12.42	14.91	2.48
	27	3.37	4.22	5.06	5.40	5.91	6.75	7.59	8.41	9.28	10.13	10.80	10.97	11.81	12.66	15.19	2.53
	⅛	3.44	4.30	5.16	5.50	6.02	6.88	7.73	8.59	9.45	10.31	11.00	11.17	12.03	12.89	15.47	2.58
3½	28	3.50	4.37	5.25	5.60	6.13	7.00	7.88	8.75	9.63	10.50	11.20	11.38	12.25	13.13	15.75	2.63
	⅛	3.56	4.45	5.34	5.70	6.23	7.13	8.01	8.91	9.80	10.69	11.40	11.58	12.47	13.36	16.03	2.67
	29	3.62	4.53	5.44	5.80	6.34	7.25	8.16	9.06	9.97	10.88	11.60	11.78	12.69	13.59	16.31	2.72
	⅛	3.69	4.61	5.53	5.90	6.45	7.38	8.30	9.22	10.14	11.06	11.80	11.98	12.91	13.83	16.59	2.77
3¾	30	3.75	4.69	5.63	6.00	6.56	7.50	8.44	9.38	10.31	11.25	12.00	12.19	13.13	14.06	16.88	2.81
	⅛	3.81	4.76	5.72	6.10	6.67	7.63	8.58	9.53	10.48	11.44	12.20	12.39	13.34	14.30	17.16	2.86
	31	3.87	4.84	5.81	6.20	6.73	7.75	8.72	9.69	10.66	11.63	12.40	12.59	13.56	14.53	17.44	2.91
	⅛	3.94	4.92	5.91	6.30	6.89	7.88	8.86	9.84	10.83	11.81	12.60	12.80	13.78	14.77	17.72	2.95
4 days	32	4.00	5.00	6.00	6.40	7.00	8.00	9.00	10.00	11.00	12.00	12.80	13.00	14.00	15.00	18.00	3.00
	⅛	4.06	5.08	6.09	6.50	7.11	8.13	9.14	10.16	11.17	12.19	13.00	13.20	14.22	15.23	18.28	3.05
	33	4.13	5.16	6.19	6.60	7.22	8.25	9.28	10.31	11.34	12.38	13.20	13.41	14.44	15.47	18.56	3.09
	⅛	4.19	5.23	6.28	6.70	7.33	8.38	9.42	10.47	11.52	12.56	13.40	13.61	14.66	15.70	18.84	3.14
4¼	34	4.25	5.31	6.38	6.80	7.44	8.50	9.56	10.63	11.69	12.75	13.60	13.81	14.88	15.94	19.13	3.19
	⅛	4.31	5.39	6.47	6.90	7.55	8.63	9.70	10.78	11.86	12.94	13.80	14.02	15.09	16.17	19.41	3.23
	35	4.37	5.47	6.56	7.00	7.65	8.75	9.84	10.94	12.03	13.13	14.00	14.22	15.31	16.41	19.69	3.28
4½	⅛	4.44	5.55	6.66	7.10	7.77	8.88	9.98	11.09	12.20	13.31	14.20	14.42	15.53	16.64	19.97	3.33
	36	4.50	5.62	6.75	7.20	7.88	9.00	10.13	11.25	12.38	13.50	14.40	14.63	15.75	16.88	20.25	3.38
	⅛	4.56	5.70	6.84	7.30	7.98	9.13	10.26	11.41	12.55	13.69	14.60	14.83	15.97	17.11	20.53	3.42
	37	4.62	5.78	6.94	7.40	8.09	9.25	10.41	11.56	12.72	13.88	14.80	15.03	16.19	17.34	20.81	3.47
4¾	⅛	4.69	5.86	7.04	7.50	8.20	9.38	10.55	11.72	12.89	14.05	15.00	15.23	16.41	17.58	21.09	3.52
	38	4.75	5.94	7.13	7.60	8.31	9.50	10.69	11.88	13.06	14.25	15.20	15.44	16.63	17.81	21.38	3.56
	⅛	4.81	6.01	7.22	7.70	8.42	9.63	10.83	12.03	13.23	14.44	15.40	15.64	16.84	18.05	21.66	3.61
	39	4.87	6.09	7.31	7.80	8.53	9.75	10.97	12.19	13.41	14.63	15.60	15.84	17.05	18.28	21.93	3.66
5 days	⅛	4.94	6.17	7.41	7.90	8.64	9.88	11.11	12.34	13.58	14.81	15.80	16.05	17.28	18.52	22.22	3.70
	40	5.00	6.25	7.50	8.00	8.75	10.00	11.25	12.50	13.75	15.00	16.00	16.25	17.50	18.75	22.50	3.75
	⅛	5.06	6.33	7.59	8.10	8.86	10.13	11.39	12.66	13.92	15.19	16.20	16.45	17.72	18.98	22.78	3.80
	41	5.13	6.41	7.69	8.20	8.97	10.25	11.53	12.81	14.09	15.38	16.40	16.66	17.94	19.22	23.06	3.84
	⅛	5.19	6.48	7.78	8.30	9.08	10.38	11.67	12.97	14.27	15.56	16.60	16.86	18.16	19.45	23.34	3.89
5⅛	42	5.25	6.56	7.88	8.40	9.19	10.50	11.81	13.13	14.44	15.75	16.80	17.06	18.38	19.69	23.63	3.94
	⅛	5.31	6.64	7.97	8.50	9.30	10.63	11.95	13.28	14.61	15.94	17.00	17.27	18.59	19.92	23.91	3.98
	43	5.37	6.72	8.06	8.60	9.41	10.75	12.09	13.44	14.78	16.13	17.20	17.47	18.81	20.16	24.19	4.03

Day of 8 Hours.	Hours.	.125	.156	.187	.20	.219	.25	.28	.312	.344	.375	.40	.406	.438	.469	.563	.094
		1.00	1.25	1.50	1.60	1.75	2.00	2.25	2.50	2.75	3.00	3.20	3.25	3.50	3.75	4.50	.75
	⅛	10.06	12.58	15.09	16.10	17.61	20.13	22.64	25.16	27.67	30.19	32.20	32.70	35.22	37.73	45.28	7.55
	81	10.13	12.66	15.19	16.20	17.72	20.25	22.78	25.31	27.84	30.38	32.40	32.91	35.44	37.97	45.53	7.59
	⅛	10.19	12.74	15.28	16.30	17.83	20.38	22.92	25.47	28.02	30.56	32.60	33.11	35.63	38.20	45.84	7.64
10¼	82	10.25	12.81	15.38	16.40	17.94	20.50	23.06	25.63	28.19	30.75	32.80	33.31	35.88	38.44	46.13	7.69
	⅛	10.31	12.89	15.47	16.50	18.05	20.63	23.20	25.78	28.36	30.94	33.00	33.52	36.09	38.67	46.41	7.73
	83	10.37	12.97	15.56	16.60	18.16	20.75	23.34	25.94	28.53	31.13	33.20	33.72	36.31	38.91	46.69	7.78
	⅛	10.44	13.05	15.66	16.70	18.27	20.88	23.48	26.02	28.70	31.31	33.40	33.92	36.53	39.14	46.97	7.83
10½	84	10.50	13.12	15.75	16.80	18.38	21.00	23.63	26.25	28.88	31.50	33.60	34.13	36.75	39.38	47.25	7.88
	⅛	10.56	13.20	15.84	16.90	18.48	21.13	23.76	26.41	29.05	31.69	33.80	34.33	36.97	39.61	47.53	7.92
	85	10.62	13.28	15.94	17.00	18.59	21.25	23.91	26.56	29.22	31.88	34.00	34.53	37.19	39.84	47.81	7.97
	⅛	10.69	13.36	16.03	17.10	18.70	21.38	24.04	26.72	29.39	32.06	34.20	34.73	37.41	40.08	48.09	8.02
10¾	86	10.75	13.44	16.13	17.20	18.81	21.50	24.19	26.88	29.56	32.25	34.40	34.94	37.63	40.31	48.38	8.06
	⅛	10.81	13.51	16.22	17.30	18.92	21.63	24.33	27.03	29.73	32.44	34.60	35.14	37.84	40.55	48.66	8.11
	87	10.87	13.59	16.31	17.40	19.03	21.75	24.47	27.19	29.91	32.63	34.80	35.34	38.06	40.78	48.93	8.16
	⅛	10.94	13.67	16.41	17.50	19.14	21.88	24.61	27.34	30.08	32.81	35.00	35.55	38.28	41.02	49.22	8.20
11 days	88	11.00	13.75	16.50	17.60	19.25	22.00	24.75	27.50	30.25	33.00	35.20	35.75	38.50	41.25	49.50	8.25
	⅛	11.06	13.83	16.59	17.70	19.36	22.13	24.89	27.66	30.42	33.19	35.40	35.95	38.72	41.48	49.78	8.30
	89	11.13	13.91	16.69	17.80	19.47	22.25	25.03	27.81	30.59	33.38	35.60	36.16	38.94	41.72	50.06	8.34
	⅛	11.19	13.98	16.78	17.90	19.58	22.38	25.17	27.97	30.77	33.56	35.80	36.36	39.16	41.95	50.34	8.39
11¼	90	11.25	14.05	16.88	18.00	19.69	22.50	25.31	28.13	30.94	33.75	36.00	36.56	39.38	42.19	50.63	8.44
	⅛	11.31	14.14	16.97	18.10	19.80	22.63	25.45	28.28	31.11	33.94	36.20	36.77	39.59	42.42	50.91	8.48
	91	11.37	14.22	17.06	18.20	19.91	22.75	25.59	28.44	31.28	34.13	36.40	36.97	39.81	42.66	51.19	8.53
	⅛	11.44	14.30	17.16	18.30	20.02	22.88	25.73	28.59	31.45	34.31	36.60	37.17	40.03	42.89	51.47	8.58
11½	92	11.50	14.37	17.25	18.40	20.13	23.00	25.88	28.75	31.63	34.50	36.80	37.38	40.25	43.13	51.75	8.63
	⅛	11.56	14.45	17.34	18.50	20.23	23.13	26.01	28.91	31.80	34.69	37.00	37.58	40.47	43.36	52.03	8.67
	93	11.62	14.53	17.44	18.60	20.34	23.25	26.16	29.06	31.97	34.88	37.20	37.78	40.69	43.59	52.31	8.72
	⅛	11.69	14.61	17.53	18.70	20.45	23.38	26.30	29.22	32.14	35.06	37.40	37.98	40.91	43.83	52.59	8.77
11¾	94	11.75	14.69	17.63	18.80	20.56	23.50	26.44	29.38	32.31	35.25	37.60	38.19	41.13	44.06	52.88	8.81
	⅛	11.81	14.76	17.72	18.90	20.67	23.63	26.58	29.53	32.48	35.44	37.80	38.39	41.34	44.30	53.16	8.86
	95	11.87	14.84	17.81	19.00	20.78	23.75	26.72	29.69	32.66	35.63	38.00	38.59	41.56	44.53	53.44	8.91
12 days	⅛	11.94	14.92	17.91	19.10	20.89	23.88	26.86	29.81	32.83	35.81	38.20	38.80	41.78	44.77	53.72	8.95
	96	12.00	15.00	18.00	19.20	21.00	24.00	27.00	30.00	33.00	36.00	38.40	39.00	42.00	45.00	54.00	9.00
	⅛	12.06	15.08	18.09	19.30	21.11	24.13	27.14	30.16	33.17	36.19	38.60	39.20	42.22	45.23	54.28	9.05
	97	12.13	15.16	18.19	19.40	21.22	24.25	27.28	30.31	33.34	36.38	38.80	39.41	42.44	45.47	54.56	9.09
	⅛	12.19	15.23	18.28	19.50	21.33	24.38	27.42	30.47	33.52	36.56	39.00	39.61	42.66	45.70	54.84	9.14
12¼	98	12.25	15.31	18.38	19.60	21.44	24.50	27.56	30.63	33.69	36.75	39.20	39.81	42.85	45.94	55.13	9.19
	⅛	12.31	15.39	18.47	19.70	21.55	24.63	27.70	30.78	33.86	36.94	39.40	40.02	43.09	46.17	55.41	9.23
	99	12.37	15.47	18.56	19.80	21.66	24.75	27.84	30.94	34.03	37.13	39.60	40.22	43.31	46.41	55.69	9.28
	⅛	12.44	15.55	18.66	19.90	21.77	24.88	27.98	31.09	34.20	37.31	39.80	40.42	43.53	46.64	55.97	9.33
12½	100	12.50	15.62	18.75	20.00	21.88	25.00	28.13	31.25	34.38	37.50	40.00	40.63	43.75	46.88	56.25	9.38
	⅛	12.56	15.70	18.84	20.10	21.98	25.13	28.26	31.41	34.55	37.69	40.20	40.83	43.97	47.11	56.53	9.42
	101	12.62	15.78	18.94	20.20	22.09	25.25	28.41	31.56	34.72	37.84	40.40	41.03	44.19	47.34	56.81	9.47
12¾	⅛	12.69	15.86	19.03	20.30	22.20	25.38	28.55	31.72	34.89	38.05	40.60	41.23	44.41	47.58	57.09	9.52
	102	12.75	15.94	19.13	20.40	22.31	25.50	28.69	31.88	35.06	38.25	40.80	41.44	44.63	47.81	57.38	9.56
	⅛	12.81	16.01	19.22	20.50	22.42	25.63	28.83	32.03	35.23	38.44	41.00	41.64	44.84	48.05	57.66	9.61
	103	12.87	16.09	19.31	20.60	22.53	25.75	28.97	32.19	35.41	38.63	41.20	41.84	45.03	48.28	57.94	9.66
13 days	⅛	12.94	16.17	19.41	20.70	22.64	25.88	29.11	32.34	35.58	38.81	41.40	42.05	45.28	48.52	58.22	9.70
	104	13.00	16.25	19.50	20.80	22.75	26.00	29.25	32.50	35.75	39.00	41.60	42.25	45.50	48.75	58.50	9.75
	⅛	13.06	16.33	19.59	20.90	22.86	26.13	29.39	32.66	35.92	39.19	41.80	42.45	45.72	48.98	58.78	9.80
	105	13.13	16.41	19.69	21.00	22.97	26.25	29.53	32.81	36.09	39.38	42.00	42.66	45.94	49.22	59.06	9.84
	⅛	13.19	16.48	19.78	21.10	23.08	26.38	29.67	32.97	36.27	39.56	42.20	42.86	46.16	49.45	59.34	9.89
13¼	106	13.25	16.56	19.88	21.20	23.19	26.50	29.81	33.13	36.44	39.75	42.40	43.06	46.34	49.69	59.63	9.94
	⅛	13.31	16.64	19.97	21.30	23.30	26.63	29.95	33.28	36.61	39.94	42.60	43.27	46.59	49.92	59.91	9.98
	107	13.37	16.72	20.06	21.40	23.41	26.75	30.09	33.44	36.78	40.13	42.80	43.47	46.81	50.16	60.19	10.03
	⅛	13.44	16.80	20.16	21.50	23.52	26.88	30.23	33.59	36.95	40.31	43.00	43.67	47.03	50.39	60.47	10.08
13½	108	13.50	16.87	20.25	21.60	23.63	27.00	30.38	33.75	37.13	40.50	43.20	43.88	47.25	50.63	60.75	10.13
	⅛	13.56	16.95	20.34	21.70	23.73	27.13	30.51	33.91	37.30	40.69	43.40	44.08	47.47	50.83	61.03	10.17
	109	13.62	17.03	20.44	21.80	23.84	27.25	30.66	34.06	37.47	40.88	43.60	44.28	47.69	51.09	61.31	10.22
	⅛	13.69	17.11	20.53	21.90	23.95	27.38	30.80	34.22	37.64	41.06	43.80	44.48	47.91	51.33	61.59	10.27
13¾	110	13.75	17.19	20.63	22.00	24.06	27.50	30.94	34.38	37.81	41.25	44.00	44.69	48.13	51.56	61.88	10.31
	⅛	13.81	17.26	20.72	22.10	24.17	27.63	31.08	34.53	37.98	41.44	44.20	44.89	48.34	51.80	62.16	10.36
	111	13.87	17.34	20.81	22.20	24.28	27.75	31.22	34.69	38.16	41.63	44.40	45.09	48.56	52.03	62.44	10.41
	⅛	13.94	17.42	20.91	22.30	24.39	27.88	31.36	34.84	38.31	41.81	44.60	45.30	48.78	52.27	62.72	10.45
14 days	112	14.00	17.50	21.00	22.40

| | | |

for. ... first thing any man working on the piece wants to k... is: Which one it is *not* to be put on.

Very respectfully, Fred. E. Ayer.

U. S. Reclamation Service, Billings, Mont.,
April 2, 1906.

[Mr. Moses submits the following reply to this argument.—Ed.]

Sir: Mr. Ayer has made out a fairly good case from the point of view of the assembling gang and shop inspector, but the templetmaker and marker must also be considered. The first use of the drawings is in the templet shop and in the case given as an example the different columns presumably go on one set of templets. The holes for the bracket must then be noted on the templet, this being most easily done by drawing a line around the templet holes and writing within the circumscribed area the numbers "1, 2, 4, 5." Such a note can be put into a very small space, such as the edge of a pole templet, and this is one advantage. The templet next goes to the marker, who clamps it to the piece of steel, decides to mark it for Col. 1, for instance, and then sets his punch in every hole not especially marked, and in every hole having the figure "1" noted beside it. But if the use of both positive and negative notes was the custom, the marker would have to examine every note as he came to it, sometimes using his punch when figure "1" appeared, and sometimes not. This would frequently lead to mistakes, and a mistake of the marker always appears on the steel. On the other hand, the assembling gang have the holes in the steel as a check to their interpretation of the notes and if they do make mistakes in spite of this check their errors are easier to correct. As a general rule, therefore, the writer thinks the positive notes preferable.

Yours truly, John C. Moses.

Boston, Mass., April 10, 1906.

Concerning the Flow of Water from Deep Wash Borings and What it Indicates.

Sir: Referring to the letter of Mr. Geo. B. Hazelhurst, in your issue of April 5, concerning the wash borings on the Gatun Dam and the reasons for water flowing out of the casing above the level of the river, it seems to me that an entirely different explanation from any yet given is that which is given in connection with a similar phenomenon in boring artesian wells 800 ft. deep in southern Louisiana.

These 800-ft. wells pass through sand and clay in varying proportions. This material is Mississippi River silt, and is so fine that about 97% passes through a 100-mesh sieve. The method of boring these wells is to use a drive pipe about 4 ins. in diameter with two jets of water near the boring tool. Outside of this 4-in. pipe is a casing about 12 ins. in diameter. Through the drive pipe, water is pumped which washes out the material loosened by the boring tool at the bottom of the hole. This drive pipe is added to, in ordinary pipe lengths, from 16 to 20 ft. long. While the water is being pumped into the drive pipe, the silt and muddy water runs out of the casing and is either wasted or allowed to settle in a small pond and is used over again. Whenever a new length is added to the drive pipe when the bore hole has reached a considerable depth, the water runs over the top of the drive pipe slowly at a height of at times 15 or 16 ft. above the surface. The water which is obtained at a depth of 800 ft. rises only to a point 12 to 16 ft. below the surface of the ground.

As the water flows out of the drive pipe, the surface of the water in the casing gradually lowers. The explanation of this phenomenon in which the greater cross-section of water inside the casing forced the smaller cross-section of water in the drive pipe to a greater height, is that the water in the casing is a mixture of muddy silt and water, the specific gravity of which is slightly greater than the somewhat cleaner water which is forced down the drive pipe. On account of the much greater depth of the borings in southern Louisiana, the water in the drive pipe is forced 25 to 30 ft. higher than it would be with ordinary pressure of the water bearing stratum at a depth of some 800 ft.

Since the well-boring contractor withdraws his drive pipe and casing entirely, leaving nothing but the empty hole about 13 ins. in diameter and 800 ft. deep, and then lowers his well casing between the vertical sides of this hole, and since these holes are sometimes left open as long as a week without caving in, in such fine material, it is believed that an article on the artesian wells in that vicinity would be of special interest to the profession. These wells are bored from 5 to 15 ft. away from the foundations of warehouses, some of them having no piles under the walls for foundations. This is done without causing any settlement or trouble to the building. Holes 600 ft. deep have been abandoned without injuring the adjacent building structure. There are many other interesting phenomena in regard to these wells; for instance, the reason why these bore holes stand up for 800 ft. instead of caving in and filling up from the bottom, which occurs in ordinary pipe trenches 5 to 20 ft. deep in the same vicinity, is as follows: The ground water, after flowing through this fine material, is clear of everything except a slight vegetable coloring matter; it has been found better to use in the drive pipe a slightly muddy water taken from the pond, which permits a portion of the mud to settle from the muddy water coming from the casing. The specific gravity of this muddy water is greater than that of the ground water, and it therefore keeps a pressure in an outward direction from the center of the bore hole against the walls of silt. It is also probable that the muddy water tends to plaster up or cement the surface of the earth walls of the bore holes. Another interesting point is that the Mississippi River levees are built of this exceedingly fine, silty material, mentioned in the second paragraph of this letter.

Very respectfully,

L. F. Bellinger,
Civil Engineer, U. S. N.

U. S. Navy Yard, New York, April 9, 1906.

The Site for the Gatun Locks.

Sir: May I venture to call your attention to a misapprehension which, in accordance with your well-known reputation for fair dealing, you may desire to correct. The essential amendation relates to my testimony before the Senate Committee on Interoceanic Canals, to which the following reference was made in your issue of April 5:

"According to Mr. Bates there is not room enough to locate three locks there with 900 ft. usable length except by having the ends of the locks located on bad foundations in the alluvial valley."

My position on the subject was rather more tenable than that which the quotation would indicate. My statement was that the approach projected by the minority must be inadequately founded. As to the locks proper, while the foundations may go down to indurated clay, the sides for 900 ft. locks project up to 80 ft. above the rock line, perched too high on top of the rock of the hill rather than cut into solid strata. All that is required to show this, is a longitudinal section of the hill with the locks as proposed, which I have the pleasure to enclose for your convenience. Needless to say, one accurate profile of the hill weighs more in my mind than telegraphic opinions from the Isthmus.

Perhaps the following abstracts from the testimony of other engineers may show the extent to which my actual statements have been "controverted."

Hearings of Isthmian Canal Commission. Mr. William B. Parsons, Page 2037:

"SENATOR KITTREDGE.—Is it not possible to lengthen the entire lock structure so as to have a usable length of 900 ft.?
"MR. PARSONS.—It is not possible to do that and still keep the three locks in flight.
"SENATOR KITTREDGE.—Why is that?
"MR. PARSONS.—The topography of the ground (is such), falling off at both ends, that you could not get a longer structure in there."

Hearings of Isthmian Canal Commission, Mr. Alfred Noble, Page 1854:

"SENATOR KITTREDGE.—Mr. Noble, have you, during the recess, examined the drawings in the office of the Canal Commission in reference to the usable length of the locks proposed at Gatun?
"MR. NOBLE.—Yes, sir.
"SENATOR KITTREDGE.—What do they show?
"MR. NOBLE.—The published drawing seems to have been a draftsman's error in showing the lock chambers too short.
"SENATOR KITTREDGE.—What do these drawings show?
"MR. NOBLE.—I did not measure this. This information came from Gen. Davis. The draftsman also informed me that they had made a mistake and made the drawings too short; but the borings have not developed a lock site long enough for three locks.
"SENATOR KITTREDGE.—They have not?
"MR. NOBLE.—No, sir.
"SENATOR KITTREDGE.—To what length have those borings developed a lock site?
"MR. NOBLE.—They have developed a lock site long enough for two locks and something over.
"SENATOR KITTREDGE.—Of what length?
"MR. NOBLE.—Of a usable length of 900 ft."

Hearings of Isthmian Canal Commission, Mr. Frederic P. Stearns, Page 1940:

"SENATOR DRYDEN.—It has also been said here that these locks could not be lengthened. Now, I understand you to hold the contrary view, and certainly one or two other engineers hold the contrary view.
"MR. STEARNS.—I do not see how these particular locks could be lengthened. What would be done, in my opinion, if larger locks are needed, would be to build a third row of locks at this location (indicating). If that (indicating) did not give you sufficient length right immediately beside these locks, then put them farther into the hill, where there is a greater length."

Yours very truly, Lindon W. Bates.

111 Broadway, New York, April 9, 1906.

[We print the above quotations as given by Mr. Bates; but it is fair to add in explanation that since Mr. Noble and Mr. Stearns gave their testimony, the matter has been thoroughly cleared up by the testimony of Gen. Ernst. Briefly summed up: Messrs. Bates and Parsons claimed that the Gatun lock site was not long enough for a flight of three locks each 1,000 ft. in length. Gen. Ernst showed that the Gatun site is amply sufficient for these locks and also that the official plan of these locks was not in error as claimed but did show locks of 900 ft. usable length. The following is an excerpt from the official report of Col. Ernst's testimony before the Senate Committee on March 26.—Ed.]

COL. ERNST.—There have been one or two points raised in the evidence which has been before you, Mr. Chairman, which I would like to refer to. On page 1760 of the evidence I read this—Mr. Parsons was on the stand:

"SENATOR KITTREDGE.—Then, as I understand you, notwithstanding the statement in the minority report of the usable dimensions of this lock at Gatun as 900 ft. by 95 ft. in the plan presented to us the usable dimensions are in fact 790 ft. as to length?
"MR. PARSONS.—That is a fact.
"SENATOR KITTREDGE.—Is it not possible to lengthen the entire lock structure so as to have a usable length of 900 ft.?
"MR. PARSONS.—It is not possible to do that and still keep the three locks in flight.
"SENATOR KITTREDGE.—Why is that?
"MR. PARSONS.—The topography of the ground (is such), falling off at both ends, that you could not get a longer structure in there. . . . .
"There is a divide there, a ridge, with suitable material for foundations, rock or a very hard clay amounting almost to a rock, and at such reasonable depth as to be reached by the locks. But when you come to make the locks of a thousand feet each, with the space between the locks for the gates and the clearances between the locks, the ends of that structure would overhang the sides of this ridge so that the ends would not have a proper foundation. The ends would include, of course, the end gates at both ends, where it is most important that there should be a satisfactory foundation.
"The minority, therefore, decided not to use 1,000-ft. locks. In other words, three members of the minority reversed themselves in their original decision of a thousand feet and dropped back to a 900-ft. lock, so as to get in three locks of 900 ft. each in this situation.
"Then, when an objection was made to the danger of locks in flight, they still further reduced it, as Mr. Bates has pointed out, by introducing the safety gates, the second set of gates, and by putting them inside of the 900-ft. length.
"SENATOR KITTREDGE.—And thereby reducing the usable length dimension to less than 800 ft.?
"MR. PARSONS.—To something less than 800 ft."

COLONEL ERNST.—Mr. Shonts, after this evidence was given, telegraphed this to Mr. Stevens:

Confidential.] March 16, 1906.

Stevens, Panama:
Burr and Parsons testified in favor sea-level and strongly against lock, asserting Gatun Hill not large enough to permit construction three locks in series with usable length exceeding 790 ft. each, and proper foundation dam not attainable. Noble testified in favor of lock canal, but had no figures to refute statements about length Gatun Hill. Shonts.

March 17, 1906.

Shonts, Washington:
Cablegram of 16th received. I have just made careful personal examination exact site Gatun dam. There is ample length with perfect foundations for longer locks than reported by minority of board. Contradict Burr and Parsons on my authority, and say that if Nature had intended triple locks there she could not have arranged matters better. Stevens.

The Secretary of War also telegraphed to Mr. Stevens, on the 18th of March, as follows:

March 18, 1906.

Stevens, Panama:
Would it not be wise for you to examine and measure Gatun Hill with reference to the question raised by Burr and Parsons? It ought to be done, if done at all, at once. Taft.

Reply, dated March 20, 1906:

Isthmian, Washington:
Replying to Secretary Taft cable, 18th, I say limits in length required for twin triple locks, Gatun, 3,100 ft.; in width 300 ft. Have fully developed by one hundred borings, 3,800 ft. in length and 300 width, on exact site, perfect foundations, and can build two sets of three locks, each 1,150 ft. long if necessary, and perhaps much longer. Conditions ideal for construction and permanency. Stevens.

SENATOR KITTREDGE.—Does that mean that the aggregate length suitable for the lock structure is three times 1,150 ft.?

COLONEL ERNST.—That is the way he describes it—that it is abundant to build locks 1,150 ft. long or more, but of course you cannot build a lock without giving the proper supports outside of the locks themselves.

It is stated here in the first place that they cut down their length from 1,000 to 900 ft. because they did not have room. That shows that that was not the reason.

It is stated also that the 900 ft. is short. Now, here is the original drawing filed with the Commission, which I brought up here so that you could see for yourselves. It covers four different studies. The only one which we are concerned with now is this one [indicating], which is the Gatun locks in flight of three. I have had a tracing taken of that part, but I thought I would bring the whole thing here so that you can see that this is the original drawing filed by that Consulting Board.

In describing a lock, engineers have to use two lengths, one being the total length of the chamber, which they use in computing the volume of water that is required to fill it, but in that must be included room enough for the gates to swing. You cannot put in a ship the total

length of the chamber. So they have another length that they call the usable length, which is less.

The distance from point to point—that is, between the gate posts—in this case is 955 ft. in order to give 900 ft. of usable length. It is said that in that upper lock they have put this guard gate into that chamber and have encroached on it in that way. They have put it into the chamber, but they have not encroached on it.

SENATOR KITTREDGE.—I wish you would tell us just why they have not made that encroachment.

COLONEL ERNST.—That is what I had this diagram made for. This [referring to diagram] is upstream. You see, the gates all point that way. This is upstream. In the case of a boat entering the lock upstream both these gates stand open. The boat comes down here to this gate and stops. This upper gate is then closed. Now you have got three gates closed. Then this gate is opened; the boat is pushed forward 80 ft. by capstans, or whatever power is used for moving the boat. Then this other gate is closed and there are thus two gates always protecting the upper level.

SENATOR KITTREDGE.—Your safety gates are in your upper lock; is that right?

COLONEL ERNST.—One is inside and one is outside.

SENATOR KITTREDGE.—But they are connected with your upper-lock structure?

COLONEL ERNST.—Yes, sir. Ordinarily there would be simply one gate at each end. For the purposes of safety an additional gate is put up, which we call guard gates or safety gates. One of those is put outside of this space which has been devoted, we will say, to a lock without safety gates. The other one is put inside.

The distance of the corner post of the guard gate from the other gate is 80 ft.; and it would encroach that much on the usable length of the lock if you had to keep all your gates closed at the same time; but you do not have to do that.

SENATOR TALIAFERRO.—What is the usable length of the lock with all the gates closed?

COLONEL ERNST.—820 ft.

SENATOR KNOX.—What is the usable length with the gates open, which you say may be safely opened after the vessel goes in?

COLONEL ERNST.—900 ft.

SENATOR KITTREDGE.—What do you put those safety gates in there for?

COLONEL ERNST.—So that there would always be two gates to protect the summit level.

SENATOR DRYDEN.—Suppose it should be finally determined that locks longer than originally suggested should be made; that locks of 1,000 ft. usable length should be put there. Do you understand Mr. Stevens to say that the formation of the mountain and the land is such that these locks can be made of such a length?

COLONEL ERNST.—I do; yes.

Of course this movement of the vessel which I have described involves losing eight or ten minutes in going through, although it is a perfectly safe thing to do. You still have the usable length of 900 ft., with the two gates always protecting the summit level. It would be possible to make this lock long enough to shut all the gates and still have 900 ft. between them. There are some objections to that, but that is a possibility. The objections are that you want about the same cubic volume of water in one lock as in the other; and if you increase the length of this lock above that of the others, you ought to decrease the width. That can be done and make the volume the same, with a greater length and less width; but that has the objection that your gates are different. It is an advantage to have the gates all duplicates of each other. They sometimes get out of order, and it is a desirable thing to have them all duplicates; and it strikes me that this is the best arrangement they could make. But it is not so that they cannot put a 900-ft. boat through there with perfect safety—I mean, having two gates always to protect the summit level.

SENATOR DRYDEN.—Do you know of any reason why, if it is thought necessary to make these locks longer, there should be any mechanical or structural difficulty about doing it?

COLONEL ERNST.—None in the world. It is the easiest way to enlarge a lock that there is, to increase the length of the wall.

SENATOR DRYDEN.—Could they be made longer with just as much safety as the length originally suggested?

COLONEL ERNST.—Absolutely; certainly.

SENATOR DRYDEN.—And in facility of operation they could be operated as easily, could they?

COLONEL ERNST.—Yes, sir; just as easily.

I do not know but that it is proper to call attention to the continuation of Mr. Parsons's testimony the next day, having referred to his evidence, to which I have just replied. After that evidence that I have quoted before, this is what he says the next day:

"I am not attacking the ability to construct those locks at all. I want to have that distinctly understood. But, at the same time, if the locks are built, when they are built they will be unsafe for operation, in my opinion, as I explained yesterday. In other words—I lay stress not upon the inability to construct the locks or the inability to make those locks 1,000 ft. long, if necessary—**I believe that the ground is probably there to build the** locks on and that the locks can be built a thousand feet long, if it is necessary, but that if that is done you will still have locks that are unsafe to operate, on account of the locks being in series of three."

So that he toned down a little the evidence he gave; but I thought it was desirable to explain to the committee that that minority report said exactly what they intended to say, and they furnished plans for locks that could pass a boat 900 ft. in length.

Notes and Queries.

Mr. Geo. H. Freiermuth, San Francisco, writes:

In regard to the articles on "How to Remove an Instrument Stuck on Its Tripod," I would suggest that you inform the engineers that if they used the Lietz friction coupling they would have no trouble in this respect.

In the drawing of the wind bracing and connection details in Fig. 2 of the article on the Brevoort Iron Bridge, published last week, the lettering was misplaced through a draftsman's error. The letters A and B in the plan refer to the vertical connection angles (shown unshaded) instead of to the diagonal stiffener angles of the gusset.

In the obituary notice of the late H. W. Parkhurst on p. 424 of our last issue it was stated that Mr. Parkhurst was Resident Engineer of the Merchants Bridge at St. Louis under Mr. Geo. S. Morison, from 1885 to 1889. This is an error. The Merchants Bridge was built in 1889-1891 under Mr. E. L. Corthell as Chief Engineer. When the partnership of the firm of Morison & Corthell expired by limitation on May 30, 1889, each partner arranged to take charge of certain works, the plans for which had been prepared by the firm jointly. Mr. Morison wished to retain the Memphis bridge and Mr. Corthell the Merchants Bridge, and this was done. Mr. Morison retained as a matter of form the title of Consulting Engineer for the Merchants Bridge, but had nothing to do with the work.

A TABLE FOR COMPUTING PAY-ROLLS.

By Wm. Wallace Wotherspoon, C. E.*

(With inset supplement.)

While in the employ of the late Ira A. Shaler on Section 4 of the New York Rapid Transit Subway, the writer suggested making a table showing at the rates most used the amounts of pay for each hour and half-hour up to two or three weeks. Mr. Shaler and Mr. Percy Onderdonk, the paymaster, approving, the writer, with the assistance of a young cousin, Charles McLean, computed on a slide-rule for the following pay day a trial table, substantially in the form accompanying this article. This table proved a great convenience in Mr. Shaler's work, with a weekly pay-roll often amounting to $10,000.

The table is for working days of eight hours and fractions of such days, but it can be easily used for days of ten hours by pasting a strip of paper over the day column and relettering it.

Many paymasters turn time kept in hours into days and fractions of days, because from habit they more readily keep such time in mind and compute in that way, e. g., turning 82 hours into 10¼ days, instead of multiplying 82 by the hourly rate. Of course, if overtime is made and that is calculated by the same roundabout process, the chance of confusion and error is increased. Keeping time in hours and fractions of hours soon approves itself as simpler for both paymaster or workman. When a man has once been told he receives so much for a day of so many hours, he easily understands it and soon thinks in hours.

It will be found a convenience in using the table to color a few of the most used columns with contrasting tints, as red and blue, with

*Contracting Engineer, 426 W. 13th St., N. Y. City.

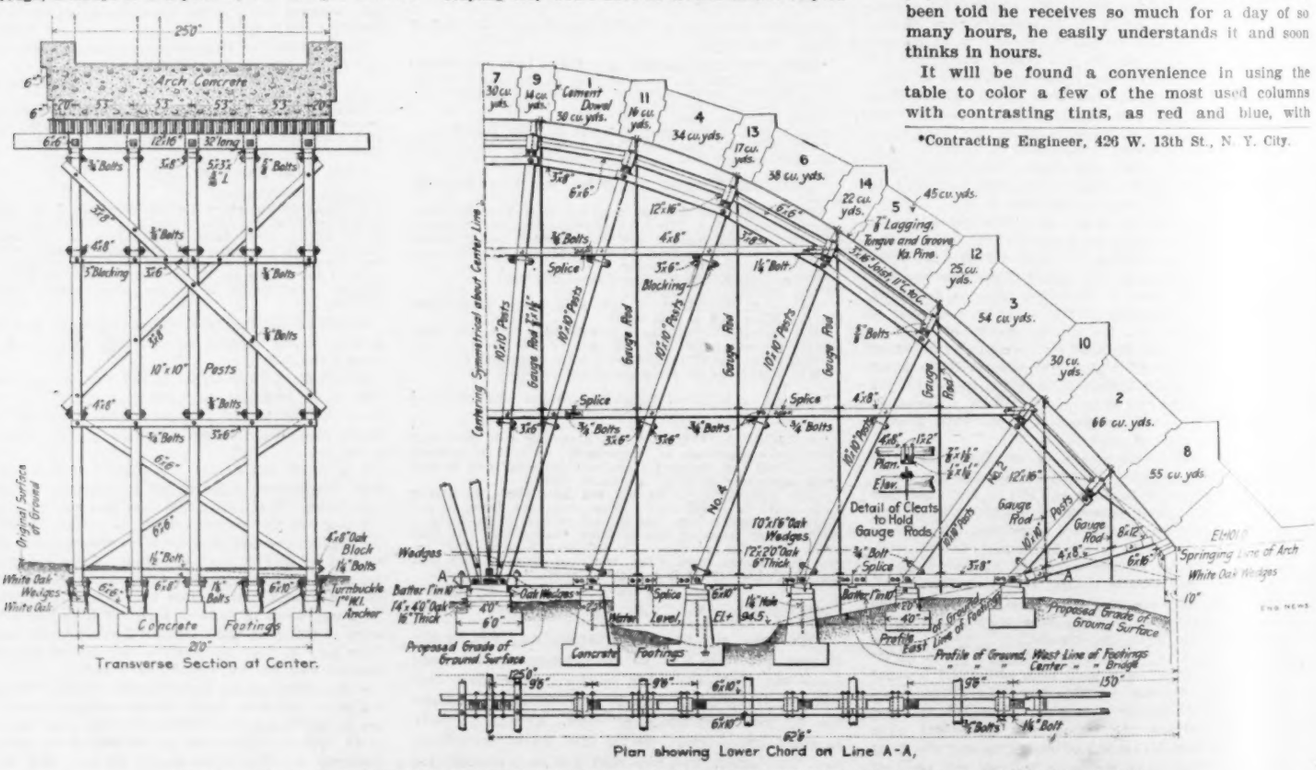


FIG 1. HALF SIDE ELEVATION AND TRANSVERSE SECTION OF CENTER FOR 125-FT. PARABOLIC ARCH.

colored pencils or a wash of dilute ink or water color. The user of the table soon becomes accustomed to connect a particular color with a particular rate without referring to the figures at the top of the column. For carrying the eye along the horizontal lines, a short rule or a T-square can be used for the vertical columns as well, and the colors can be omitted.

As a partisan of decimal notation, I venture to add that keeping working time and pay-rolls in hours and decimals of hours (especialy on piecework), which is much more convenient, both for original computation and for proving totals, will be greatly facilitated when we have time-clocks with 24-hour dials and stamping mechanism exhibiting hours and tenths of hours. Such a clock I ordered made some years ago, even furnishing drawings for the dials and portions of the mechanical parts; but the manufacturer, after a long delay for taking out patents for himself, turned the clock out in hours and fiftieths of hours, which was not so helpful.

It may be added that the figures in the table have been carefully and independently checked, and it has already been extensively used, as stated above, in making out pay-rolls. Its accuracy, therefore, can be relied upon.

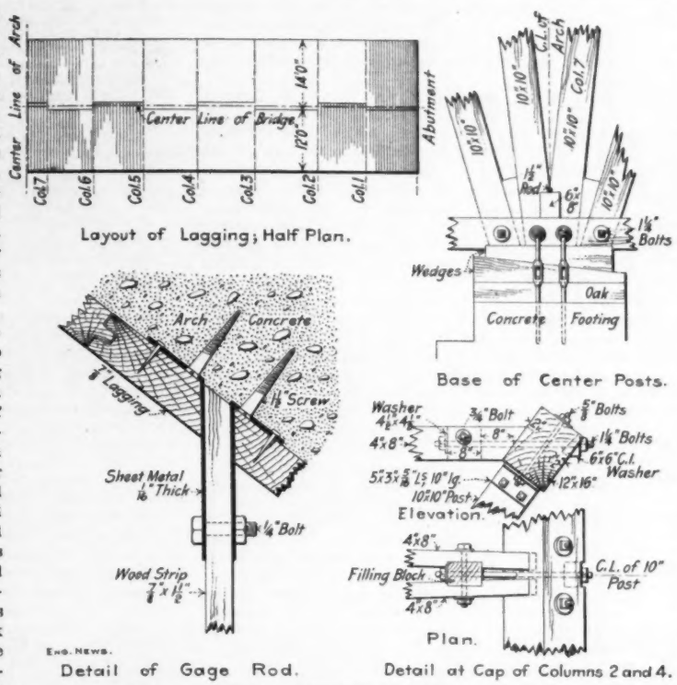


FIG. 2. SPECIAL DETAILS OF ARCH CENTER.

SPECIAL DESIGN OF CENTERS FOR PARABOLIC CONCRETE ARCH BRIDGE, WASHINGTON, D. C.

An arch center of 125-ft. span, designed to be erected without a derrick, or even a gin pole, is shown in the accompanying drawings. The bridge for which this center was designed was described in detail in Engineering News of Nov. 16, 1905. It is a parabolic arch of concrete, with a clear span of 125 ft. and a rise of 39 ft., and is intended to carry 16th St., Washington, D. C., over the small stream known as Piney Creek, or Piney Branch.

The construction of the center is clearly shown by the drawings of Figs. 1 and 2, Fig. 1 giving a half-side elevation and transverse section and Fig. 2 showing certain special details. Referring to Fig. 1, it will be seen that the center consists of 14 radial bents carrying joists spaced 11 ins. apart on centers and covered with tongued and grooved lagging arranged in panels, as shown by one of the sketches in Fig. 2. The bents rest on and are anchored to concrete footings or pedestals, one under each post. The structural details are best explained by the drawings.

In the matter of general design, the most important feature is perhaps that noted above, of the possibility of erecting the center without special hoisting plant. The mode of procedure is indicated by the sketch Fig. 3. The posts, caps and braces are framed into bents on the ground and in the positions shown by the sketch. This sketch, it may be noted, shows both the process of erection with a gin pole and the mode of procedure without other hoisting apparatus than a block and tackle. The method of erection without a gin pole will be considered first.

The bent first to the left of the center (bent 7 L) is erected by means of tackle running from its top or cap to a tree or deadman on the high ground. As soon as bent 7 L is shoved up the tackle is attached to its cap and bent 7 R is hoisted into position and braced to bent 7 L by the brace B. Bents 6 R, 6 L, 5 R, 5 L, etc., are then hoisted one after another by tackle attached to the caps of bents already erected. As each bent comes into position it is connected by a tie similar to tie B; in Fig. 1 these ties are shown running continuously around the top of the center just below the cap. Each bent swings into position on the 1¼-in. heel bolts and the heel blocks H. The method of erection with a gin pole is clearly indicated by the drawing Fig. 3.

The demolition of the center will be accomplished merely by reversing the process of erection. As will be noted from the sketch in Fig. 2, the lagging is arranged to facilitate the work of demolition. In respect to this and some of the other details, the engineer writes:

> If the lagging is put in without any particular system it is extremely difficult to take it out after the centers are struck. The gagé rods shown in the elevation and in the detailing in the right-hand corner are for the purpose of keeping record of the deformation of the centering during construction and also of the deformation of the arch ring after construction. The relationship of the bottoms of these rods to points in the ground are recorded and they are read from time to time during construction so that the engineer may know absolutely what is going on in his timber work. They were employed for the first time as far as I know in the construction of the Connecticut Avenue Bridge this last season and were very successful.

The center as described was designed in the office of Mr. W. J. Douglas, Engineer of Bridges, Washington, D. C., under the direction of Colonel John Biddle, Engineer Commissioner, District of Columbia; Captain J. J. Morrow, Assistant to the Engineer Commissioner, and Mr. W. P. Darwin, Assistant Engineer.

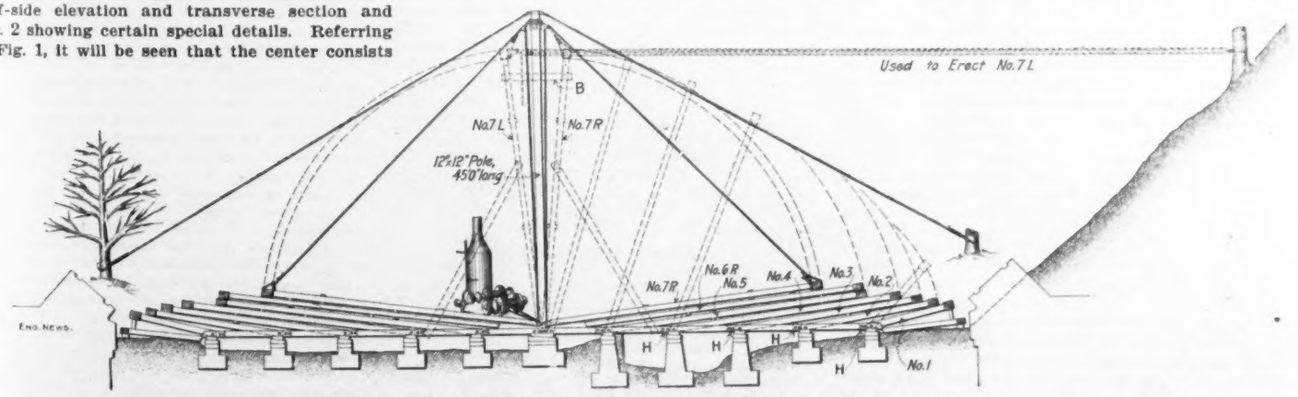


FIG. 3. SKETCH SHOWING METHOD OF ERECTION OF ARCH CENTER.

THE SAVANNAH HARBOR CONTRACTORS, John F. Gaynor and Benjamin D. Greene, who conspired with former Capt. Oberlin M. Carter to defraud the Government on contracts for work in the Savannah district, in the '90's, were, on April 12, found guilty on all the counts of the three indictments against them for conspiracy, embezzlement and presenting false claims. On the following day Judge Emory Speer sentenced each of them to imprisonment for two, four and four years on the several indictments, but the sentences run concurrently and a deduction is permitted for good behavior, so that the actual term of imprisonment will be less than four years. In addition a fine was assessed against each of them of $575,749.90, the amount which each was charged with having fraudulently obtained from the United States. The trial of Greene and Gaynor lasted 13½ weeks. In sentencing the prisoners, Judge Speer said:

> In some, no doubt, who are imbued with the belief that all they can get from the Government is honest graft, your conviction may excite indignation, astonishment, and perhaps, not a little alarm. It seems, indeed, that the public should awaken to the prevalence of this dangerous inclination. The magnificent contributions from the National Treasury made by Congress for the welfare of the people all imperatively call for a lesson in thunder tones to faithless, conniving, unprincipled representatives of the Government and the unscrupulous contractors or other persons who would conspire to plunder the public treasury.
>
> It will be well for our governmental authorities to reflect that unless the obstructive construction placed upon our removal statutes, which delayed this case so long, shall be avoided, as recommended by the President and the Attorney General, it will be wholly impossible to have the speedy trial of criminal cases and the greater the crime and the more powerful and richer the culprit, the greater will be the difficulty of bringing him to trial.

NIAGARA ELECTRIC POWER TRANSMISSION AT cost is proposed in a report recently submitted to the Ontario Legislature by the Hydro-Electric Power Commission, appointed by the Provincial Government some months ago. The scheme involves the construction of a large power-house and of main and branch transmission lines to supply a large number of municipalities distributed all the way from Toronto to Windsor (across the river from Detroit, Mich.) The length of main line to Windsor would be 227 miles; to Sarnia, 201 miles; to St. Mary's 127 miles; to London, 124 miles; to Guelph, 91 miles; to Toronto, 88 miles; and to Hamilton, 46 miles. Estimates of the cost of power at four points have been made, including charges for operation, repairs, replacement fund and interest at 4½%. These are based on 1 HP. for 24 hrs., delivered to consumers. At St. Thomas, which would be on a branch line from London, the estimated charges would be :Full load of 2,000 HP., $26.03 per HP.; ¾ load, or 1,500 HP., $29.06; ½ load, or 1,000 HP., $35.08. For Toronto, the figures are: Full load of 50,250 HP., $16.53; ¾ load, $16.91; half load, $17.15. The

site proposed is above the intake of the Ontario Power Co., with a tunnel tail-race about 5,000 ft. long. An alternative site, 18 miles to the west, would give 300 ft. head and demanding much less water per horsepower developed.

A FATAL EXPLOSION ON THE BATTLESHIP "Kearsarge" occurred during target practice near Guantanamo, Cuba, on Friday, April 13. The explosion occurred in the lower (13-in.) section of the forward turret, after the last shot had been fired and while several 13-in. charges of smokeless powder were being taken down the ammunition hoist to the magazine. Three sections of one charge burned, but another charge which was on the way to the magazine and one section left in the gun were not ignited. Two officers and seven men were killed, and half a dozen others injured. The cause of or accountability for the accident has not yet been determined.

EXPLOSIONS of gas in manholes on Eighth, Ninth and Tenth Aves., between 49th and 55th Sts., New York City, at various times since the first of the year have caused much damage to property and injured numerous people. These explosions have always occurred at high tide when the mouths of the sewers are submerged, thus cutting off all escape of gases except through the vents of the manholes. It was at first supposed that the explosions were due to illuminating gas which had leaked into the sewers from the mains and been ignited by sparks from the electric cars, but after investigation it has been concluded that the cause of the explosions was not illuminating gas, but gasoline waste which had been run into the sewers from the numerous automobile garages in that vicinity. It is the practice of these garages to run all waste oil and gasoline into the sewers when cleaning motor cars, and this waste becoming mixed with air forms an explosive mixture which is fired by sparks in the conduit of the electric street railway lines.

STATISTICS OF CEMENT PRODUCTION in 1905 are just made public by the U. S. Geological Survey. The total production of all kinds of hydraulic cement in 1905, including Portland, natural-rock, and slag or Puzzolan cements, was 40,894,308 barrels, valued at $36,012,189. This was an increase of 9,219,051 barrels, valued at $9,980,209, over the production of the previous year.

Of the total amount of cement manufactured in the United States in 1905, 36,038,812 barrels were Portland cement, with a value of $33,326,523; 4,473,049 barrels were natural-rock cement, valued at $2,413,052; and 382,447 barrels were slag or Puzzolan cement, valued at $272,614.

EXPORTS OF AGRICULTURAL PRODUCTS from the United States for the eight months ending with February, 1906, broke all records, the total value for that period being $700,695,000. The highest previous record was made in 1904 when the total for the corresponding eight months was $658,645,000. It is of much interest that there should be this growth in our exports of raw materials at a time when exports of manufactures are also greater than ever before and when home consumption, due to prosperous times, also exceeds all previous records.

SEVERAL NORTH DAKOTA IRRIGATION PROjects under the U. S. Reclamation Service have progressed to the point where bids will soon be asked. On the Buford-Trenton Project the plans will call for electrically-operated pumps to serve 6,000 acres, with an option on additional units to supply a total of about 10,000 acres. On both the Williston and the Nesson projects similar plants, to serve about 10,000 acres each, are proposed. A common electric generating station will serve the Buford-Trenton and the Williston projects.

A WATER SUPPLY MAP OF NEW YORK STATE is proposed by the State Water Supply Commission. Mr. John C. Graves, Secretary of the Commission, Albany, N. Y., is sending out portions of the topographic maps of the state, published by the U. S. Geological Survey, with the request that municipal authorities indicate on the maps the location and nature of their sources of water supply.

A CURIOUS AESTHETIC REGULATION occurs in the new building ordinances of the city of Darmstadt, Germany, promulgated during the past year. This clause forbids the use of "artificial building materials" on the fronts of buildings on prominent streets. Brick is included in this category of artificial building materials.

PERSONALS.

Mr. S. D. Higley who has been connected with the Thomson Meter Co., Brooklyn, N. Y., for the past 14 years, has been elected Secretary of the Company.

Mr. W. C. Armstrong has been appointed Bridge Engineer, Chicago, Rock Island & Pacific Ry. to succeed Mr. A. D. Page promoted to Principal Assistant Engineer.

Mr. L. R. Lemoine has been elected General Manager of the New Jersey Zinc Co., with headquarters at New York City. Mr. R. M. Catlin has been appointed Superintendent of Mines with headquarters at Franklin Furnace, N. J.

Mr. George H. Blakeley, M. Am. Soc. C. E., formerly Chief Engineer and Contracting Manager of the Passaic Rolling Mill Co., Paterson, N. J., has been appointed Structural Engineer of the Bethlehem Steel Co., South Bethlehem, Pa.

Mr. J. S. Langthorn, M. Am. Soc. C. E., has resigned from the Department of Bridges, New York City, where he was Engineer in Charge of the Boroughs of Brooklyn and Richmond, to accept the position of Division Engineer in the Reservoir Department of the New York City Board of Water Supply. His office will be at West Hurley, N. Y.

Mr. W. C. Nixon has been elected President of the Texas & Gulf Ry. with headquarters at Galveston, Tex., Mr. J. K. Keefe, Vice-President and General Manager, with headquarters at Longview, Texas; Mr. G. A. Rogers, Secretary and Treasurer, with headquarters at Longview; Mr. A. C. Torbert, Assistant Secretary and Assistant Treasurer with headquarters at Galveston; Mr. K. S. Hull, Superintendent, headquarters Longview; Mr. L. P. Goodwyn, Master Mechanic, headquarters Longview.

Mr. A. S. Zinn, Assistant Engineer on track elevation for the Chicago & Western Indiana R. R., at Chicago, has resigned to accept the position of Engineer in Charge of the double-track work of the Michigan Central R. R. in Canada. His headquarters will be at St. Thomas, Canada. Mr. Zinn was formerly Principal Assistant Engineer of Maintenance of Way for the Chicago, Rock Island & Pacific Ry. and is a member of the Western Society of Engineers and the American Railway Engineering and Maintenance of Way Association.

Mr. L. A. Osborne, Third Vice-President, Westinghouse Electric & Manufacturing Co., Pittsburg, Pa., has been elected Second Vice-President to succeed Mr. Frank H. Taylor resigned. As Third Vice-President, Mr. Osborne directed the engineering and manufacturing activities of the company. He will now also assume direction of the commercial activities. Mr. Osborne is a graduate of Cornell University and has been in the employ of the Westinghouse Co. since 1891, holding successively the positions of Assistant Superintendent, Assistant to the Vice-President, Manager of Works, Fourth Vice-President and Third Vice-President.

Mr. E. H. Sniffin has been elected Third Vice-President and Mr. Arthur West Fourth Vice-President of The Westinghouse Machine Co., Pittsburg, Pa., these offices having just been created by the Board of Directors. Mr. Sniffin will be in charge of the Sales Department as heretofore, while Mr. West retains the title and position of Chief Engineer. Mr. Henry L. Barton formerly General Superintendent of the East Pittsburg Works of the Company has been appointed Manager of Works to succeed Mr. William A. Bole, resigned, to accept the Vice Presidency of the Westinghouse Foundry Co., Pittsburg, Pa., of which he assumes entire management. Mr. Bole is, however, retained as Consulting Engineer of the Westinghouse Machine Co.

Obituary.

Joseph L. Breen, General Manager of the People's Railway Co., of Dayton, O., was killed March 29 at Dayton. While crossing a temporary trestle over the Miami River on a car he endeavored to inspect the supporting bents of the trestle and was hit with a pole or plank and instantly killed. Mr. Breen was 40 years old, and was born at Alexandria, Va. He became Assistant Superintendent of Construction for the Woodridge and Turner Engineering Co, of New York City, in 1892, and supervised the building of numerous railways in different parts of the country. During 1897 to 1899 he was engaged in track construction with William Wharton, Jr. & Co., Inc., and was appointed Superintendent of Construction of the American Railways Co., Philadelphia, Pa., in 1900. He was made General Manager of the People's Company in 1902.

ENGINEERING SOCIETIES.

COMING MEETINGS.

NATIONAL MUNICIPAL LEAGUE.
April 24 to 27. Annual meeting at Atlantic City, N. J. Secy., Clinton Rogers Woodruff, North American Bldg., Philadelphia, Pa.

AMERICAN RAILWAY ASSOCIATION.
April 25. Semi-annual meeting at Chicago, Ill. Secy., W. F. Allen, 24 Park Place, New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
May 1 to 3. Annual meeting at Ithaca, N. Y. Secy., S. S. Sadtler, 39 South 10th St., Philadelphia, Pa.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 1 to 4. Semi-annual meeting at Chattanooga, Tenn. Secy., F. R. Hutton, 12 West 31st St., New York City.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 22 to 24. Annual meeting at Chicago, Ill. Secy., W. H. Merrill, Jr., Chicago, Ill.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
May 28 to June 1. Annual convention at Milwaukee, Wis. Secy., Ralph W. Pope, New York City.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
June 5. Annual meeting at Atlantic City, N. J. Secy., W. C. L. Eglin, 136 Liberty St., New York, N. Y.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
June 5 to 7. Annual convention at Cleveland, O. Secy., Richard Moldenke, Watchung, N. J.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 18. Annual convention at Atlantic City, N. J. Secy., J. W. Taylor, Old Colony Bldg., Chicago, Ill.

MASTER CAR BUILDERS' ASSOCIATION.
June 13. Annual convention at Atlantic City, N. J. Secy., J. W. Taylor, 658 Rookery, Chicago, Ill.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 26. Annual convention at Thousand Islands, N. Y. Secy., Chas. Warren Hunt, 220 West 57th St., New York, N. Y.

AMERICAN WATER-WORKS ASSOCIATION.
July 10 to 14, inclusive. Annual meeting at Boston, Mass. Secy., J. M. Diven, 14 George St., Charleston, S. C.

SOCIETY OF ENGINEERS OF EASTERN NEW YORK.—The annual meeting was held April 11, at Albany, N. Y., when the following officers were elected: President, James F. McElroy, The Consolidated Car Heating Co., Albany, N. Y.; Vice-President, J. A. Clapp, General Electric Co., Schenectady, N. Y.; Treasurer, W. I. Slichter, General Electric Co., Schenectady, N. Y.; Member of Finance Committee (to serve three years), William Dalton, American Locomotive Co., Schenectady, N. Y.; Member of Executive Committee (to serve three years), H. A. Van Alstyne, State Engineer, Albany, N. Y.

AMERICAN MOSQUITO EXTERMINATION SOCIETY.—The third annual convention of this society was held in New York on the afternoon of April 11. Two papers were read at length and several by title. For the purpose of presenting in brief and forcible language some of the essential features regarding the mosquito and its suppression, a "Mosquito Brief" had been drawn up by an Advisory Board of Entomologists. This was submitted to the convention and adopted. It consisted of twelve short articles, which altogether would fill about a third of one of these columns. It is understood that this brief will be printed for wide distribution. Dr. Charles B. Davenport, of Cold Spring Harbor, N. Y., who is connected with the Carnegie Institute, read a paper in which he pointed out some of the deficiencies and delinquencies of rural boards of health. These boards, he held, could not be expected to conduct a successful campaign against mosquitoes and flies, owing to their lack of sanitary knowledge and the fact that their executive health officer is generally a local practicing physician whose income is largely dependent upon treatment of patients suffering from malaria and from the diseases transmitted by flies. It was therefore urged by the speaker that in all but the large cities health officers should be appointed by the state and that they should in every case be sanitary experts, but should not be engaged in private medical practice. Practically all of the officers of the previous year were elected. The principal officers, all of New York City, are as follows: President, William J. Matheson; Vice-President, Walter C. Kerr; Treasurer, Frederick C. Beach; Secretary, Henry Clay Weeks, Bayside, L. I., New York City; Assistant Secretary, Edward Hagaman Hall.

BROOKLYN ENGINEERS' CLUB.—At a regular meeting held in the Polytechnic Institute Building April 12 a constitutional amendment, increasing the annual dues of corporate and associate members to $10, with an initiation fee of $10, was amended by adding a clause raising the non-resident members dues to $5. This amendment will be voted on at the next meeting.

The committee appointed some two months ago to investigate and make recommendations on the proposed revision of the building laws of the city of New York made a preliminary report. This committee, together with similar committees from several other societies, after studying the resolution passed by the Board of Aldermen for revising the building laws, decided that the selection of the board of experts as then determined was not for the best interest of all concerned, and therefore appointed a sub-committee to confer with the chairman of the Building Committee of the Board of Aldermen for the purpose of obtaining their cooperation in having the aforementioned resolution rescinded and one which the joint committee submitted substituted. The Building Committee of the Board of Aldermen agreed with the joint committee of the societies, that the resolution should be changed and have laid the matter before the Board of Aldermen, where it at present rests.

Mr. Hugh T. Wreaks presented a paper on "Rubber-covered wire; its manufacture and tests in regard to its life and insulating properties." Beginning with the drawing of the copper wire he gave a general description of the tinning of the wire, the application of the rubber, the vulcanizing of the rubber, the weaving of the outer braid and the waxing. He then followed with a description of the physical and electrical tests used to determine the properties of the finished wire and showed the limitations and defects of the present mode of testing. He closed his paper with a summary of the "Specifications for Wire" as required by the National Board of Fire Underwriters, the United States Government, the Pennsylvania R. R. and the Railway Signal Association.